FICHE CHAMPS DE DOCUMENT

CHAMPS A RENSEIGNER PAR LE REDACTEUR

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1/B	22/05/02	Document update following RIDs and collocation meeting EDI-MA01-01 EDI-MA01-02 EDI-MA01-03 RID-MA01-01 RID-MA01-02 RID-MA01-03 RID-MA01-04 RID-MA01-05	L Le Baratoux	Paragraphs : §3.1.2.2 §3.1.2.2 §general §general §3.2.2 §3.2.3 §3.1.4.3 §3.1.4.2
1/C	15/10/02	- Update following ESA RIDS: DH-030-RQ (HD creation) SO-009-CO (add of cap time installation) SO-053-IM (32/64/128 EEG cap description and pictures added) - Update following MEEMM Crew review (lock of HD door, use of velcro, add of pictures to describe the cap operations). - Presentation of all the MEEMM User Manuals - GSE content update - Headbox fixation with velcro as a baseline- New HB photos - GSE description update - Budgets update - GSE interface description - Detailed steps added - Maintenance connector pin out completed - Packing instructions completed - Description of GSE installation - List of FM spares completed	L Le Baratoux	 § 4.2.1.1 § 4.2.1.2 § 3.1.2 § 4.2.1.2 and associated appendixes. § 1.1 § 3.1.1 § 3.1.2.2 §3.1.2.6 §3.1.4 §3.2.3 §4.2 §7 §8 §9 §10
1/D	15/08/03	• Explanation on camera packing for launch following Safety Review Phase III comment • GSE PC photo added • Update of consumables list • Scheme update • Clarification on the number of bipolar channels. Consumables list update	L Le Baratoux	§4.2.1.1.2, §4.2.1.2 §3.1.6 §3.2.1.1.1 §3.2.2 §4.1.1&§4.1.2

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1/E	01/06/05	• Photogrammetry pre tasks update • Precision on camera calibration process and CF selection • HD preparation • HD reception • Labelling update – EPM LTU environment completed • GSE scheme and item list update • Document issue numbers • Acronyms list update • TMTC data update • RID 22786 - A reference to RD2 document (EPM/MEEMM SW User Manual) has been added to chapter 4.3 (MMI displays). • Clarification on experiment scenario series (LHB/HHB, analog channels) • Add of ground instructions of use related to CE directive • Add of RD30 (CE declaration of conformity)	L. Le Baratoux	§4.2.1.1.1 §4.2.1.1.2 §4.2.1.1.3 §4.2.1.3.2 §4.2.2 §9.1 §2 §1.2 §3.1.5 § 4.3 § 4.1 § 9.3 (new paragraph) §2.2

SOMMAIRE

SUMMARY

1 INTRODUCTION

1.1 PURPOSE AND SCOPE

The MEEMM (Multi-electrode ElectroEncephalogram Mapping Module) is part of the EPM Facility (European Physiology Modules Facility) which is one of the major International Space Station facilities developed within the scope of ESA's Microgravity Facilities for Columbus program.
The MEEMM is one of the initial set of Science Modules developed for the first EPM mission. It is dedicated to the study of the brain activity by measuring both EEG/EMG and Evoked Potentials.

The Payload and GSE Operation Manual is the main document providing detailed documentation, data and instructions for operations and maintenance of the payload and ground segment equipment (GSE).
This document refers to 3 others User Manual dedicated to SW and Digitizing tasks for some specific operations:

- **RD2 :EPM/MEEMM SW User Manual**
  This document describes the use of MEEMM SW
  The intended readership of this document is :
  - OHB personal be able to operate the MEEMM during test and integration
  - Profile developer, i.e. people in charge of developing a scientific session using MEEMM.
  - Test engineers, as the content of this document shall be known for writing test scripts.

- **RD25 : EPM/MEEMM SW Transfer Document**
  This document identifies the MEEMM Softwares and how to build and install it in the operational environment.
  The document is updated after main SW releases.

- **RD26 : EPM/MEEMM 3D Electrodes Modelling User Manual**
  This document is in charge to explain the way to proceed to obtain the electrodes location thanks to the Photomodeler software.

Additionally, a synthesis of data and requirements to support the MEEMM/EPM ground integration phase is provided in "Ground Processing data" (RD10).

1.2 ACRONYMS

AD	Applicable Documents
ADC	Analog to Digital Conversion
BOB	Break-Out Box
BW	BandWidth
CAM	Commercial, Avionics, Military
CLSW	Carrier control Laptop SoftWare
CMRR	Common Mode Rejection Ratio
CPU	Central processing unit
CTRL	Control
DC/DC	Direct current to direct current conversion
EEG	Electro-Encephalogram
EMG	Electro-MyoGraphy

EP	Evoked Potential
EPM	European Physiology Modules
ESA	European Space Agency
FFT	Fast Fourier Transform
FSE	Flight Support Equipment
GCP	Guided Crew Procedure
GSE	Ground support equipment
HDRL	High Rate Data Link
HHB	High frequency HeadBox
HKP	HouseHeeping Data
IAP	Interactive Automatic Crew Procedure
I/O	Input / Output
ISS	International Space Station
LAN	Local Area Network
LSB	Last significant bit
LHB	Low frequency HeadBox
LRU	Line Repalaceable Unit
LTU	Laptop Computer Unit
Mbps	Mega Bit Per second
MEEMM	Multi-electrode ElectroEncephalogram Mapping Module
MPLM	Mini Pressurised Logistics Module
MRI	Magnetic Resonance Imagery
MSB	Most significant bit
MTBF	Mean Time Between Failure
ORU	On-orbit Replaceable Unit
PU	Panel Unit
RD	Reference Document
RMS	Reference Mission Scenario
SAC	Standard Active Container
SEE	Single Event Effect
SM	Science Module
SMSC	Science Module Computer
SPLC	Standard payload computer
SW	Software
Sync	Synchronisation
T	Temperature
TBC	To be confirmed
TBD	To be defined

TMTC	Telemetry and Telecommand
USE	User Support Environment
UTC	Universal Time Correlated
V	Voltage
VDC	Voltage direct current

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

AD	Document Number	Issue	Rev	Date	Title
1	EPM-OHB-SOW-0003	2	-	18/12/00	Statement of Work for EREMS Science Module MEEMM for the European Physiology Modules Facility – Phase CD
2	EPM-ESA-RQ-001	2	0	Dec 00	EPM- System Requirements Document
3	EPM-OHB-RQ-0001	3	A	25/10/02	Science Module Interface Requirements Document (SMIRD) for the European Physiology Module
4	EPM-ERM-SP-0001	1	G	22/05/02	EPM/MEEMM Science Module Specification
5	COL-RIBRE-MA-0007-00	1	-	30/03/01	COLUMBUS Payload Accommodation Handbook Attached Pressurized Module (APM)
6	COL-RIBRE-SPE-0164	1	-	30/03/01	COLUMBUS Pressurized Payloads Interface Requirements Document
7	EPM-OHB-LI-0055	1	C		MEEMM TM/TC Data definition

2.2 REFERENCE DOCUMENTS

RD	Document Number	Issue	Rev	Date	Title
1	EPM-ERM-RP-0012	2	D	03/06/03	EPM/MEEMM Design Report
2	EPM-ERM-MA-0002	1	C	14/04/05	EPM/MEEMM SW User Manual
3	Deleted				
4	Deleted				
5	Deleted				
6	Deleted				
7	EPM-ERM-PL-0006	2	C	30/06/03	EPM/MEEMM Maintainability Assessment and Inputs to Maintenance Plan
8	EPM-ERM-RP-0001	1	E	30/06/03	EPM/MEEMM Life Cycle Analysis Report
9	EPM-ERM-RP-0015	2	C	30/06/03	EPM/MEEMM FMECA & SPF List
10	EPM-ERM-PL-0012	1	D	30/06/03	EPM/MEEMM Ground Processing Data
11	EPM-ERM-RP-0002	3	A	30/06/03	EPM/MEEMM Resources Budget Report
12	Deleted				
13	Deleted				
14	FCS&I Section SSODB	Prelimi		December	BOEING

		nary		1997	Flight Crew Support and Integration (FCS&I) Section of the Space Station Operations Data Book (SSODB)
15	EPM-ERM-RP-0008	3	A	30/06/03	EPM/MEEMM Electrical and EMC Analysis Report
16	EPM-ERM-DDD-0001	1	A	29/08/03	EPM/MEEMM Detailed Design Document
17	EPM-ERM-ADD-0001	2	A	29/08/03	EPM/MEEMM SW Architectural Design Document
18	EPM-ERM-RP-0010	2	C	15/10/02	EPM/MEEMM Operational Analysis Report
19	EPM-ERM-RP-0004	3	B	10/10/03	EPM/MEEMM Thermal Analysis Report
20					Vitaport 2 Digital Recorder Operator's manual
21					Vitaport 3 Digital Recorder User's manual
22					Vitaport 3 Digital Recorder Operator's manual
23					Columbus User's manual
24	EPM-ERM-LI-0008	2	B	31/01/04	Delivery Item List
25	EPM-ERM-MA-0003	1	G	16/01/04	EPM/MEEMM SW Transfer Document
26	EPM-ERM-MA-0004	1	B	10/02/04	EPM/MEEMM 3D Electrodes Modelling User Manual
27	EPM-OHB-ICD-0009	1	A		Interface Control Document
28	EPM-ERM-SP-0002	1	C	30/03/02	EPM/MEEMM EEG cap specification
29	EPM-ERM-PR-0012	1	A	26/05/03	EPM/MEEMM Acceptance test procedures
30	EPM-ERM-TN-0025	1	A	18/04/05	EPM/MEEMM CE declaration of conformity

3 PAYLOAD DESCRIPTION

3.1 GENERAL DESCRIPTION

3.1.1 COMPLETE PAYLOAD DESCRIPTION

The MEEMM (Multi-electrode ElectroEncephalogram Mapping Module) is part of the EPM Facility (European Physiology Modules Facility) which is one of the major International Space Station facilities developed within the scope of ESA's Microgravity Facilities for Columbus program.

The MEEMM is one of the initial set of Science Modules developed for the first EPM mission. It is dedicated to the study of the brain and muscle activity by measuring both EEG/EMG and Evoked Potentials.
The MEEMM Science Module :

- operates according to the following exclusive different modes :

Mode	Number of channels	Number of bipolar interfaces (allowing EMG acquisitions)	Maximum Bandwidth	Maximum Sampling frequency	Signal envelop
Fast stationary	Up to 32	Up to 32	1,5 Hz – 10 kHz	40 kHz	25 mVpp
Slow stationary	Up to 128	At least 32	0,01 Hz – 570 Hz	2,2 kHz	25 mVpp
Ambulatory & sleep	Up to 16	Up to 4	0,3 Hz – 150 Hz	1 kHz	According to selected amplifier gain

The selection of acquisition path will be made by SW and harness choice between EEG/EP cap, EMG electrodes and headboxes.

EMG acquisitions only include conventional surface EMG acquisition (without electrical stimulations). The MEEMM acquisition channels shall allow to acquire low impedance signals.

- acquires and stores the raw scientific data channels (continuous acquisition) as well as 3 other external analogue inputs on a removable 40 Gbyte-hard disk in a synchronised process
- acquires external triggering digital signals using a 8-bit digital interface :
  - with the sample relative accuracy for sampling frequencies up to 10 kHz
  - with 0,1 ms for higher sampling frequencies
- Includes an impedance tester function
- determines the position of the electrodes once mounted on the subject, using a dedicated MEEMM digital camera. The position calculation shall be performed on ground using appropriate software.
- displays the following results for monitoring purpose using the EPM Laptop interface :
  - Impedance test results (available when no acquisition is performed)
  - Required FFT spectra, EEG/EMG data and EP processed data for experiment monitoring purpose

The MEEMM Science Module will be composed of different units :

- **Main Unit included in an active container of EPM facility in charge of :**
  - Amplifying and digitising 32 high frequency channels (with a sampling rate up to 40 kHz)
  - Management and storage of up to 128 low frequency digital information (sampling rate up to 2,2 kHz) or up to 32 high frequency digital information (sampling rate up to 40 kHz)
  - MEEMM management and communication with EPM data handling system and with a laptop,
  - Impedance/calibration functions
  - MEEMM power conditioning

- **Stowable items in a passive container including :**
  - Sensors
    - EEG/EP electrode caps including cap equipped with electrodes to pick up the signal
    - Surface EMG electrodes,
    - Ambulatory and sleep varied sensors including EEG and EMG electrodes
  - Headboxes in charge of pre-conditioning the signal
    - Two low frequency headboxes near the electrodes, each implementing 64 bipolar acquisition channels (amplification, digitising steps).
    - One high frequency headbox near the electrodes, which implements 32 bipolar acquisition channels (pre-amplification step).
  - Harnesses to link the sensors, the headboxes and the main unit for the different operational configurations
  - A portable unit referred as PORTEEM dedicated to ambulatory and sleep studies (16 channels)
  - A digitizing camera
  - Consumables
    - Cleaning wipes
    - Gel application set
    - Batteries for the PORTEEM
    - Removable hard disks
  - Spare for unitary stowage items
- **MMI SW**
- **GSEs dedicated to MEEMM ground support during flight (combined with EPM GSE services) as well as MEEMM support for standalone configuration :**
  - MEEMM GSE PC including:
    - Trigger and EEG/EMG simulation UNIT (HW/SW)
    - adaptor for MEEMM HD
    - HD formatting SW
    - MMI SW (identical to on board MMI SW)
    - Photo post processing SW
    - SMSC simulation unit (HW/SW) (stand alone configuration)
  - GSE box:
    - 28 Vdc power supply (stand alone configuration)
    - Air cooling (stand alone configuration)
  - Commercial standard laptop unit (BDCM standalone configuration)

Note: RD24 “EPM/MEEMM DIL” shows which items are provided with the GSEs of the different models

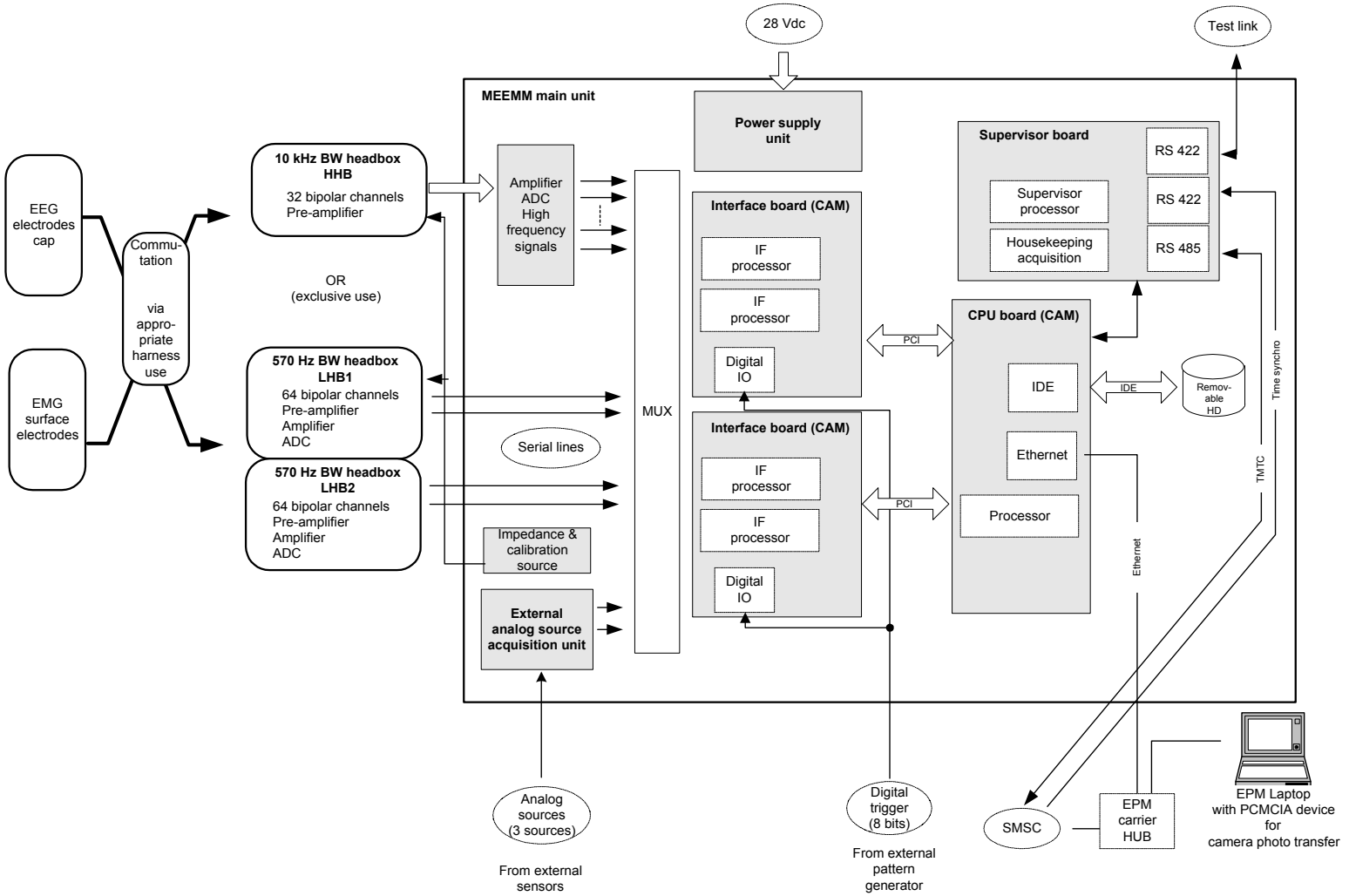


Figure 1 : MEEMM baseline architecture (Stationary configuration)

3.1.2 PHYSICAL CHARACTERISTICS OF EACH MAJOR UNIT

3.1.2.1 MEEMM Main Unit

MEEMM uses for the Main Unit an EPM 4PU removable SAC which is front mounted and back supported by the permanent rack mounted interface structure (EPM Guide Frame).

The side walls provide cut-outs for the inlet of EPM forced air loop. As part of the container structure the inlets are protected by a metallic mesh to prevent particles from floating into the container.
The rear panel is provided with a cut-out for air outlet with the interface structure to the EPM Guide Frame and air flow shutter. It provides also each a blind mated type data and power connector and two load carrying shear pins interfacing with the Guide Frame connector bar.

The MEEMM front panel is fixed via the standard mounting holes to the front frame of the SAC and provides cut-out for main features for the Main Unit operations as, ON/OFF switch, power and data connectors and an opening for hard disk insertion.
MEEMM Main Unit is depicted on Figure 2 with appropriate labelling.

Figure 2: EPM MEEMM Standard Active Container

3.1.2.2 MEEMM Headboxes

In non operating mode the Head Boxes (2 Low Frequency headboxes and 1 High Frequency headbox) are stowed in a passive container.
During operations, the Headboxes have to be fixed on EPM rack (or another rack). The headboxes are equipped with velcro on each large sides. Various possibilities have been discussed to fix the headboxes on the rack wall :

- **Baseline solution**
  The headboxes are fixed on the EPM rack (e.g. stowage container front face) using velcro.
- Other option :
  The headboxes are attached using Columbus/ISS provided tools (given in Table 1).

Tool Name	Document-chapter where tool is described	Tools required for
Articulating Post Assembly (AP) Part nbr G11F5122-1	RD14 chapter 1.2 « Equipment Restraints »	Fixing of Headboxes to Seat Track (AP fixed on Seat Track)
Seat track Equpment Anchor Assembly (STEA) Part nbr G11F5120-1	RD14 chapter 1.2 « Equipment Restraints »	Fixing of Headboxes to Seat Track (STEA fixed on AP)
Adjustable Length Tether Assembly (ALT)) Part nbr G11F5140-1	RD14 chapter 1.2 « Equipment Restraints »	Fixing of Headboxes to Seat Track (ALT fixed on STEA, ALT straps the Headbox (es))

Table 1 : COLUMBUS / ISS standard tools used by MEEMM

The headboxes dimensions are given in Table 2.

Headbox	Depth (mm)	Height (mm)	Width (mm)
One Low Frequency headbox	184	58	390
High Frequency headbox	198	68	180

Table 2 : MEEMM Headboxes dimensions

The Low Frequency headbox interfaces :
- With the sensors with 2 circular connectors 79 points –Male – MIL-C- 38 999 series III
- With the Main Unit data link with 1 circular connector 22 points –Female - MIL-C- 38 999 series III
- With the Main Unit power link with 1 circular connector 22 points –Male - MIL-C- 38 999 series III

Figure 3 shows the Low frequency Head Box pictures.

Figure 3 : Low frequency Head Box picture

The High Frequency headbox interfaces :
- With the sensors with 1 circular connector 79 points –Male - MIL-C- 38 999 series III
- With the Main Unit data link with 2 circular connector 55 points –Female - MIL-C- 38 999 series III
- With the Main Unit power link with 1 circular connector 22 points –Male - MIL-C- 38 999 series III

Figure 4 shows the High frequency Head Box pictures.

Figure 4 : High frequency Head Box picture

3.1.2.3 Camera

The chosen camera for MEEMM Photogrammetry needs is the PENTAX OPTIO330RS which has the following features:

- Metallic external envelop
- 2048 x 1536 maximum resolution
- External power interface
- Dimensions : 95mm x 35mm x 60mm

Figure 5 : MEEMM Camera

3.1.2.4 Portable Equipment (PORTEEM)

As portable sleep/ambulatory equipment for the EEG/EMG measurements a commercial product VITAPORT2 of TEMEC is used, referred as PORTEEM. In non operating condition the PORTEEM is stowed in a passive container.

The Vitaport2 configuration used for the PORTEEM application is composed of the module with an additional module :

- The data acquisition module (core module) including the display interface which is the upper module is the Figure 6
- The analog amplification module referred as EEG16 which is the lower module is the Figure 6 (Gold colour).

The PORTEEM external dimensions are the following : 47mm x 90mm x 160mm.

Figure 6 : Configuration of the PORTEEM

3.1.2.5 Sensors and accessories

3.1.2.5.1 EEG electrode cap

The EEG electrode cap for the MEEMM application is :

- Commercial classical gel cap
- Electro-cap from Electro-Cap International (ECI - US)

The electrode positions are based on an extension of the 10-20 system. Nevertheless, due to the number of wires for the 128 electrode cap, some distortions are possible compared to the theory. Digitising process will allow to take into account theses distortions (refer to paragraph 4.2.1.3).

The Electro Cap is stretched over the subjects head using both hands from the front to the back of the cap in a smooth motion and fastened thanks to a chin strap.

Figure 7 : 32, 64 and 128 electrode caps

For photogrammetry, the cap is equipped with a scale ruler fixed by velcro. A dermatological pen is used to put temporary marker on the subject.

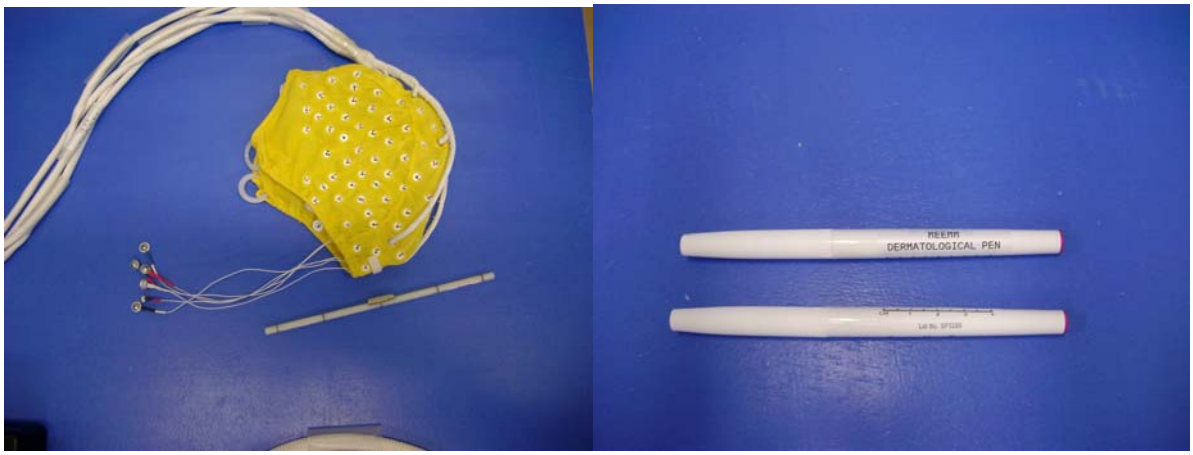


Figure 8 : 128 electrode cap with scale ruller- Pen

Each of the electrode mounts have a hole in the middle and underneath the hole, embedded in the plastic mount, is a small donut-shaped electrode. The electrode is attached to a wire which comes out of the back of the cap.

The gel injection in the electrodes of the cap is based on exactly the same method that is used in all clinics for EEG measurements: the gel will be inserted in the electrodes mount holes using a syringe with a blunted needle.

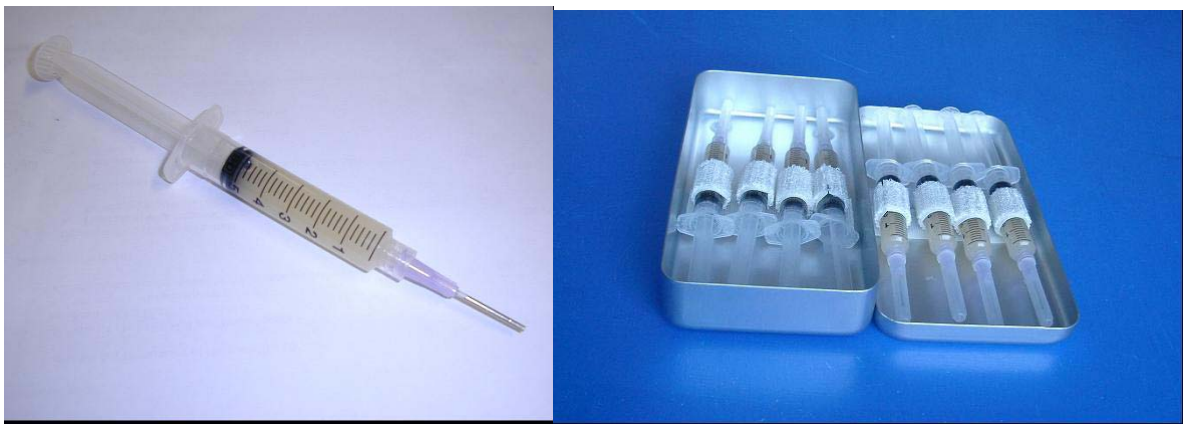


Figure 9: Syringe with blunted needle and syringes box

For individual electrodes, alcohol wipes, specific gluing cream and adhesive roller are required.

Figure 10 : Adhesive Roller, wipes, gluing cream

3.1.2.5.2 EMG sensors

The MEEMM harness for EMG application is based on :

- The use of individual or dual pre-gelified standard surface EMG electrodes
- MultibioSensors electrodes

The photo here below shows a zoom on two types of EMG electrodes that can be provided. The snapping parts is integrated within a specific EMG harness (the white plastic interface is suppressed).

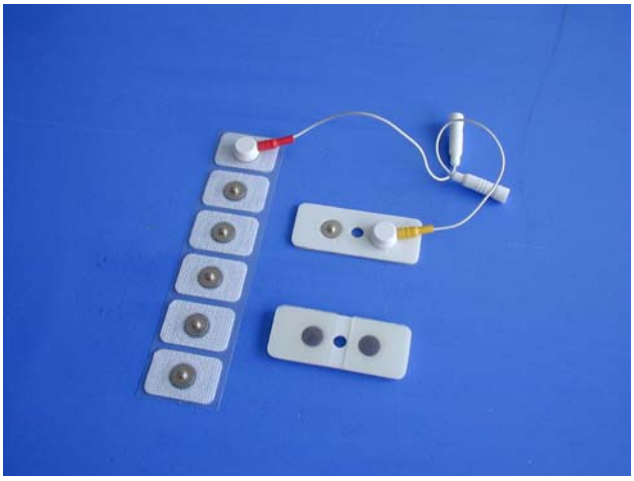


Figure 11 : One use surface EMG electrode

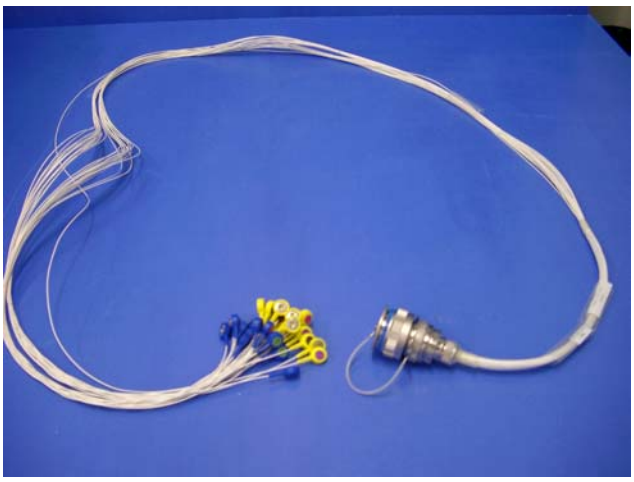


Figure 12 : EMG 16 harness

32 EMG pairs and 16 EMG pairs harnesses will be provided.
Nevertheless, as the position and the type of each channel depend on the experimental sequence (arm muscles response, finger muscles response, leg, etc.....), new harnesses can be required for specific scientific scenario.

3.1.2.5.3 Ambulatory and sleep sensors

The portable acquisition system has to be designed to acquire 16 channels. The number of specific monopolar and bipolar channels depends on the chosen portable device.
The Vitaport2 acquisition unit baseline is to use the 16 module configuration including :

We plan to use a 16 channel EEG /Polysomnography acquisition system which complies with various types of sensor required for the sleep and ambulatory studies :

- 12 EEG electrodes cap
- ECG electrodes
- Strain-gauge respiration channel
- EMG surface electrodes

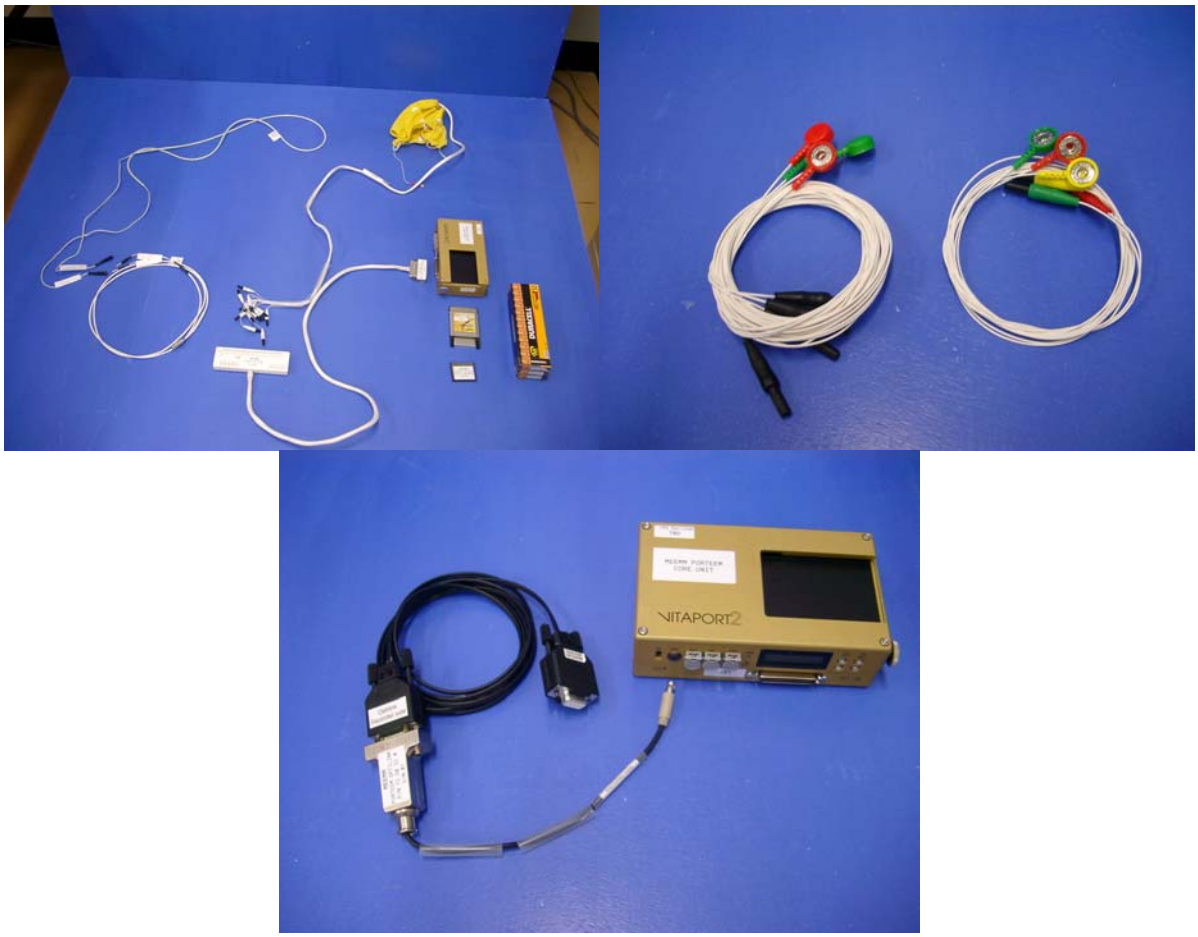


Figure 13 : PORTEEM sensors and accessories (Optilink)

3.1.2.6 GSE

The MEEMM GSE is composed of two main HW/SW sets. The first set is used only for ground sites testing and standalone activities. This set includes :

- MEEMM GSE main box
  This mechanical box is used to connect the various MEEMM interface to allow check out and MEEMM command in stand alone configuration.

Figure 14 : GSE main box

It also includes the following units :
- 28 Vdc power supply
This item is a commercial laboratory power supply device : 220V/110V to 28 Vdc. The double power source is required to allow MEEMM stand alone configuration.

- Ethernet switch
This item is a commercial Ethernet switch equipped with 5 outputs.

- Generator boards integrated in the MEEMM GSE PC
  - Trigger and EEG/EMG simulation unit (HW/SW)
  - RS links simulation unit (HW/SW)

- Air cooling powered by the MEEMM GSE main box

Figure 15 : Air cooling system

- Commercial standard laptop unit

- GSE Attenuator box
  This box performs the physical interface between the GSE analog generator interface box and the headboxes inputs.
  Plugs are used to connect the attenuator box to the headbox input connectors

Figure 16 : GSE Attenuator box and plugs

- GSE analog generator interface box
  This box performs the physical interface between the Trigger and EEG/EMG simulation board inserted in the MEEMM GSE PC, the digital interface on the MU front panel and the GSE Attenuator box.

Figure 17 : GSE analog generator interface box

The second set is used both for ground testing and standalone activities and Flight operations support. It includes :

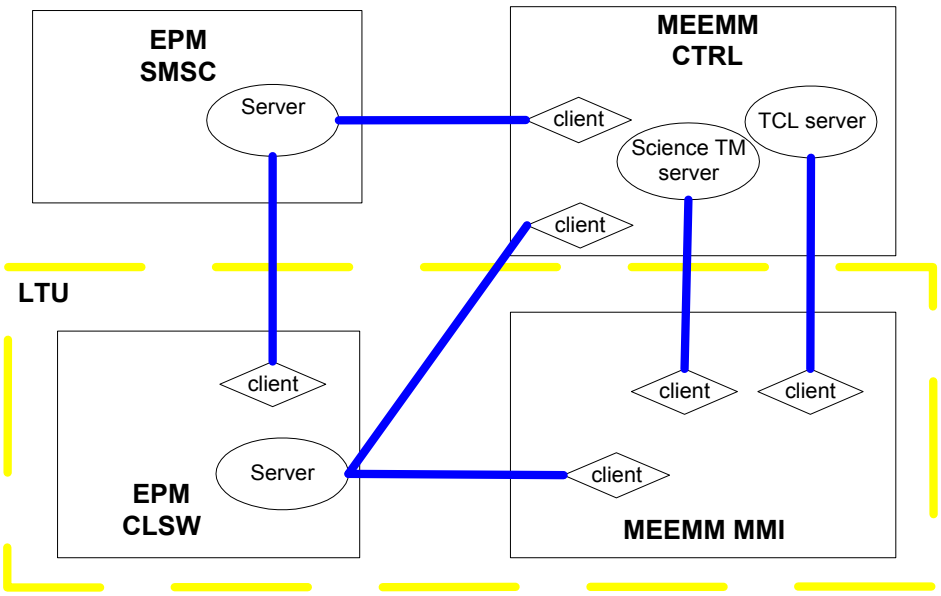
- MEEMM GSE PC including adaptor for MEEMM HD
- Various SWs, for which main use or concept are given in this document but reference information are provided in dedicated documents :
  - HD formatting SW (refer to RD2 “EPM/MEEMM SW User Manual”)
  - Photo post processing SW (refer to RD26 “EPM/MEEMM 3D Electrodes Modelling User Manual”)
  - MMI SW (identical to on board MMI SW) (refer to RD2 “EPM/MEEMM SW User Manual”)
  - PORTEEM SW (identical to on board SW) (refer to RD23 “Columbus User’s manual”)
  - Session profile generation SW (refer to RD2 “EPM/MEEMM SW User Manual”)

3.1.3 THE RD24 “EPM/MEEMM DIL” SHOWS WHICH ITEMS ARE PROVIDED WITH THE GSES OF THE DIFFERENT MODELS.

OPERATIONAL MODES AND ON-BOARD CONTROL

This paragraph gives only high level information on the operational modes as most of these modes are transparent for classical on-board operations. Links to reference documents are provided.

The on board MMI/CTRL control configuration is the following :



All the MEEMM user interface command will be handled by the CLSW (Carrier control Laptop SoftWare) on the LTU, using EPM dedicated interface.

For the MEEMM Science Module SW, the different possible states are :

- Check Out
- Start-up
- Set-up
- Nominal
- Wait-On-Sync
- Test

The list of telecommands authorized for each mode is provided in AD7 “MEEMM TM/TC Data definition “.

For the 3 last modes, experiment sub modes are used :

- Idle : MEEMM is waiting for a command
- Normal acquisition : normal EEG/EMG data acquisition without recording
- Impedance : MEEMM acquires data in impedance testing mode
- Recording : MEEMM acquires and store data on hard disk.
- Calibration : MEEMM in calibration mode

These modes are detailed in RD17 “EPM/MEEMM SW Architectural Design Document” and RD16 “EPM/MEEMM SW Detailed Design Document”. The commands associated for each mode are provided in RD2 “EPM/MEEMM SW User Manual”.

3.1.4 RESOURCES, POWER AND THERMAL CHARACTERISTICS

3.1.4.1 Data rate and storage capacity

For MEEMM stationary configurations, the raw EEG/EMG data are stored on a removable hard disk. This storage medium also contains the photo, calibration and impedance files.

As discussed in RD18 “EPM/MEEMM Operational Analysis Report”, we assume that typical durations of an experiment scenario are one hour for the low frequency experiments and 20 minutes for high frequency ones.

Taking into account these assumptions and that the MEEMM Science Module is equipped with a removable hard disk of 40 Gbytes capacity, the recording capabilities of the MEEMM SM are the following :

Configuration	Recording capabilities
128 signals at 2,2 kHz	At least 10 sessions
32 signals at 40 kHz	At least 8 sessions

To satisfy the same requirements for the ambulatory equipment with a typical duration of an experiment scenario of 8 hours, the PORTEEM is equipped with a compact flash disk (SanDisk, 256 MB capacity) inserted in a standard compact flash dish adapter to be compatible with PCMCIA ATA cards.

Taking into account these assumptions, the recording capabilities of the PORTEEM are the following :

Configuration	Recording capabilities
Ambulatory 16 signals at 200 Hz	At least 1 session

The operations linked to hard disk exchange are described in paragraph 4.2.

For data down-linking, the offered MEEMM capabilities are the following :

- Telescience operation during an acquisition session :
  - The MEEMM transmits to the EPM carrier the same experiment data as those displayed on the laptop
  - This transfer is performed using the Ethernet link between the MEEMM main unit and the EPM carrier
  - We can only guarantee the near real time performances for the transmission from the MEEMM to the EPM.
  - The associated display environment required by the MEEMM GSE display SW shall be provided by the EPM carrier and EPM GSE.
  - Complete raw experiment data can not be transmitted during the experiment session.

- Experiment data transfer after an acquisition session
  - The MEEMM internal hard disk is used in playback mode and the raw experiment data are transferred to the EPM carrier using the Ethernet link
  - Based on a maximum MEEMM/EPM transfer rate of 1 Mbit/s (LAN capabilities according to AD3), splitted between packets for ground and packets for MMI :
    - For a 128 electrode session at 2,2 kHz sampling frequency, the transfer to the EPM requires at least 4,5 hours for a 1 hour acquisition session.
    - For a 32 electrode session at 20 kHz sampling frequency, the transfer to the EPM requires at least 3 hours for a 20 minute acquisition session.
  - To obtain the global downlinking duration from MEEMM to ground, the EPM/ground HRDL capabilities have also to be taken into account. At the moment, it appears that the capabilities of this EPM/ground HRDL are quite similar to those of the MEEMM/EPM link, resulting in similar required duration.

3.1.4.2 Consumables

The specific Increment stowage items are very dependent of the scientific sessions that will be carried.

This following average budget is related to consumables items required for a specific increment based on the following assumptions (refer to RD18 “EPM/MEEMM Operational Analysis Report”) :

- 2 x ambulatory/sleep sessions
- 2 x 32-EEG low frequency sessions
- 1 x 32-EEG high frequency sessions
- 2 x 32-EMG high frequency sessions (up to 64 surface electrodes)
- 3 x 64-EEG low frequency sessions
- 3 x 128-EEG low frequency sessions

This budget is based on FM measurements.

Part No	Classification / Item Name	Qty	Mass (g)		Dimensions (mm)		
			per Item	total	Height/Ø	Width	Depth
	EEG Electrode Caps						
12.30.14.0	12 EEG electrode positioner	3	130	390	50	120	200
12.30.13.0	32 EEG electrode positioner	3	200	600	50	140	200
12.30.12.0	64 EEG electrode positioner	3	360	1 080	50	220	200
12.30.11.0	128 EEG electrode positioner	3	560	1 680	50	300	200
	EMG Electrodes						
12.30.21.0	EMG Single Electrode (set of 6 electrodes)	16	11	176	5	102	126
12.30.22.0	EMG Dual Electrodes (set of 2 pairs of electrodes)	32	7	224	5	112	126
	Consumables						
12.40.72.0	Syringes	56	12	672	30	17	175
12.40.71.0	Syringes Box	7	135	945	36	95	185
12.40.40.0	Alcohol Cleaning Wipe	20	5	100	2	60	80
12.40.73.0	Adhesive Roller	1	19	15	32	52	52
12.40.74.0	Signa Cream Tube	1	102	102	30	45	175
12.40.80.0	Dermatological Pen	2	12	24	10	10	150
12.40.60.0	PORTEEM Batteries	8	25	200	50	14	14
12.40.10.0	Hard Disk	5	287	1 435	20	84	160
12.40.90.0	Scale Ruler	1	7	7	20	5	5

Table 3 : Temporary stowage items volume and mass budgets

Note : The number of EEG caps can be decreased if the information of required sizes is known for each increment.

3.1.4.3 Power budget

The MEEMM required primary nominal voltage is 28 VDC available at the SAC rear panel. On this bus, the operating current is from 0,2A to 4,8A (10 ms max before circuit breaker action).

Additionally, two power ON/OFF manual switch (Headboxes and Camera) which enable the MEEMM to power when required the associated deployable devices are provided on the MEEMM Main Unit front panel.. These switches are equipped with a green LED indicating power presence on the Headboxes and Camera power front panel connectors.
The camera branch is protected thanks to a specific limiter / circuit breaker circuit with the following characteristics :

- VNom : 4,5V
- INom : 1 A
- IMax : 1,5 INom

The isolated / headboxes branch is protected thanks to a specific limiter / circuit breaker circuit with the following characteristics :

- VNom : +/- 5V
- INom : 0,25 to 0,3 A
- IMax : 1,5 INom

3.1.4.4 Power consumption

This budget is based on FM measurements.

Configuration	Power consumption (typical)
Main Unit +one LHB	60.5 W
Main Unit + two LHBs	63 W
Main Unit + HHB	59 W
Main unit + Camera	39 W
Main unit (no connected deployable items – Stand by mode)	28W to 36 W

Table 4 : MEEMM various items power consumption

3.1.4.5 Thermal budget

Two types of items can be considered:

1. The Main Unit enclosed in a 4 PU Active Container dissipating mainly in the ACS (EPM Air Control System)
2. Items resulting in Heat dissipation in the Cabin

The power dissipated by those items are:

ITEMS	POWER DISSIPATION
MAIN UNIT	58 W (LHB configuration)
for which front panel dissipation in cabin is:	
per convexion	< 1.5 W (1)
per radiation	< 7.5 W (1)
DEPLOYABLE ITEMS	
HHB	1.2 W
LHB 1	2,5 W
LHB 2	2,5 W
Camera	4 W
Porteem	0.8 W (batteries)

The resulting thermal budget for the main MEEMM configurations is the following :

Configuration	Total Power dissipation	*Including the following Power dissipation In Cabin (1)*
Main Unit +one LHB	60.5 W	*11,5 W*
Main Unit + two LHBs	63 W	*14 W*
Main Unit + HHB	59 W	*10 W*
Main unit + Camera	39 W	*9 W*
Main unit (no connected deployable items – Stand by mode)	28 to 36 W	*5 W*

(1) in worst case in regard of the dissipation in the cabin (i.e 18°C for the cabin air and cabin environment temperatures, warm temperatures for other SAC I/F (ACS, panels…))

Tables and graphs showing the expected thermal behaviour of the payload in normal and worst case conditions are given in RD18 “EPM/MEEMM Thermal Analysis Report”.

3.1.5 TELEMETRY AND TELECOMMAND DATA

The commands are received by MEEMM Main Unit from the RS485 interface nominal or redundant. They are processed by the MEEMM SPVR-SW.
The House-Keeping data are managed by the SPVR SW and sent periodically to the EPM Carrier via the RS 485 interface (nominal or redundant).

The detailed description of these telecommand and telemetry data (format, parameter description, sampling rates, design limits, data validity criteria) are given in AD7 “MEEMM TM/TC Data definition”.

Three types of critical housekeeping data are directly transmitted to the EPM without supervisor SW processing:

- 2 analog output lines, on the rear panel data connector, sent directly to the EPM/Carrier Control, the Primary Voltage and the Primary Current.
- 2 temperature measurements transmitted to the EPM using dedicated thermistor lines (PWR block, Front Panel)
- 3 digital O are used, one for the supervisor unit alert status (representative of any fault detection and isolation), the second for the MEEMM secondary power status, the last one for the MEEMM main circuit breaker status.

3.2 DETAILED DESCRIPTION

3.2.1 HARDWARE ITEMS – GLOBAL VIEW

The tables hereafter describe the different items associated with MEEMM hardware and show their main functions.

3.2.1.1 Stationary mode

3.2.1.1.1 Items and Electronics circuits

Element	Item	Function
EEG/EP electrode cap set	Cap	• Electrode cap (including harnesses) on the astronaut head Up to 128 electrodes dedicated to both EEG and EP recording. • Associated reference electrode • Associated ground electrode
	Consumables	• Conductive gel • Syringes and blunted needles • Cleaning wipes • Adhesive tape
	Accessories	• Dermatological Pen • Scale ruler

Element	Item	Function
Adaptor to link the EEG caps to headboxes	EEG32 Low Frequency Headbox harness (x4)	• Adaptor to link the EEG cap (by group of 32 EEG electrodes) to low frequency headbox
	EEG32 High Frequency Headbox harness	• Adaptor to link the EEG cap (by group of 32 EEG electrodes) to high frequency headbox

Element	Item	Function
Set of surface EMG electrodes	Electrodes	• EMG surface electrodes
	Consumables	• Cleaning wipes • Spare EMG surface electrodes

Element	Item	Function
Harness set to link EMG electrodes to headboxes	EMG16 Headbox Harness	• Harness to link 16 pairs of EMG electrodes to high or low frequency headbox
	EMG32 Headbox Harness	• Harness to link 32 pairs of EMG electrodes to high or low frequency headbox

Element	Item	Function
64 channel low frequency headbox 1	EEG/EP/EMG low conditioning/ADC board (x2)	• Protection + Pre-amplifiers + amplifiers (32 bipolar channels) • Conversion to digital data 22 bits • 1 serial digital data output

Element	Item	Function
64 channel low frequency headbox 2	EEG/EP/EMG low conditioning/ADC board (x2)	• Protection + Pre-amplifiers + amplifiers (32 bipolar channels) • Conversion to digital data 22 bits • 1 serial digital data output

Element	Item	Function
Harness set to link headboxes to the main unit Plugs	Low Frequency Headbox DATA1 Harness	• Low channel data transmission from the low frequency headbox to the main unit when a single LHB is used
	Headbox POWER1 Harness	• Power supply lines between the main unit and the low or high frequency headbox when a single headbox is used
	Low Frequency Headbox DATA2 Harness	• Low channel data transmission from the low frequency headbox to the main unit when both headboxes are used
	Headbox POWER2 Harness	• Power supply lines between the main unit and the low or high frequency headbox when two headboxes are used
	High Frequency Headbox DATA Harness	• High channel data transmission from the high frequency headbox to the main unit
	Headbox Calibration Plug (x4)	• Plug required for LHB and HHB acquisition channels calibration
	Software Download Plug	• Plug required for SPVR SW download, to be connected on the MU front panel
	RS485 Redundant Plug	• Plug required to use the redundant RS485 interface, to be connected on the MU front panel

Element	Item	Function
High frequency headbox	EEG/EP/EMG high first stage conditioning board (x4)	• Protection + differential pre-amplifiers (8 bipolar channels) • 8 analog data outputs
	Power supply regulation board	• Regulation function of the secondary voltages for the whole high frequency headbox

Element	Item	Function
Main unit	4 DC/DC Converter boards	• Bus Filter • Power Conversion, secondary voltages delivery (isolated, unregulated or regulated according to supplied function) • Current limiter/circuit breaker
	EEG/EP/EMG high conditioning board (x4)	• 8 EEG/EMG amplifiers channels • Conversion to digital data 24 bits • 2 serial digital data outputs
	Adaptor board	• Low frequency headbox signal isolation stages • 5V/3,3V DSP interface adaptor • Low and high frequency channel multiplexing in front of the DSP unit • Impedance/calibration source
	Synchro board	• Acquisition of external analog sources • Acquisition chains clock and control signal generation
	DSP board (x2)	• Acquisition of digital trigger events • Data file formatting, header generation
	CPU board	• System management • Communication with SMSC via Ethernet link • Data transfer to/from removable hard disk • Acquisition chains configuration
	Storage unit	• Removable hard disk to perform both on line recording and mass storage functions • Interface with CPU board
	Supervisor unit (2 boards)	• Time synchronisation with SMSC • Acquisition internal temperatures • Acquisition of monitoring parameters (secondary voltages, current…) • RS485 and testlink interface with SMSC
	Up and down Consumables	• Removable harddisk

Element	Item	Function
Digitizing unit	Dedicated MEEMM Camera	• Measurement of position of electrodes
	Harness Camera	• Power supply transmission from the main unit to the camera
	Storage unit	• Compact flashdisk and associated adaptor

3.2.1.1.2 Interface functions

Three major interfaces are experiment dedicated :

- Headboxes EEG/EMG inputs
- Digital trigger input
- Analog sources input

Headboxes EEG/EMG inputs

- Differential inputs (refer to RD27 “Interface Control Document”.for connector pin out and interface scheme)
- LHB - Maximum Input range : 0,8 mVpp to 30 mVpp (according to programmed gain : 150, 500, 2500 or 7000)
- HHB - Maximum Input range : 1,4 mVpp to 28 mVpp (according to programmed gain : 170, 500, 1600 and 3800)

Digital trigger input

- Input amplitude : TTL levels
- Rising or falling edge detection is SW programmable
- The high or low level duration shall be upper than 5 x 1/ Fs and 2 ms
- Refer to RD27 “Interface Control Document”.for connector pin out and interface scheme

Analog sources input

- Maximum input amplitude : +/- 10 V pp
- Refer to RD27 “Interface Control Document”.for connector pin out and interface scheme

3.2.1.2 Ambulatory and sleep mode

3.2.1.2.1 Items and Electronics circuits

Element	Item	Function
PORTEEM	Sensors	• EEG/EMG and other sensors (up to 16)
	Consumables	• Spare associated sensors • Cleaning wipes • Sensor fixation set • Batteries for the processing unit
	Harness PORTEEM	• Harness to link ambulatory &sleep sensors to the portable processing unit
	Processing unit	• Experiment data acquisition
	Up and down Consumables	• Compact flashdisk and associated adaptor

3.2.1.2.2 Interface functions

The PORTEEM equipment has a single type of operational interfaces : the sensors input one. The use of a PORTEEM dedicated interface unit – the patchpanel – limits the operator possible choices to the selection of programmed gain within the acquisition chain.

This programming is done thanks to a dedicated commercial SW that will be part both of the MEEMM on board SWs (implemented on the EPM LTU) and of the GSE deliveries (referred as PORTEEM “Columbus” SW).

3.2.2 SOFTWARE ITEMS

The definition of the MEEMM computer software items is presented on Figure 18. In grey are shown the SW items that are parts of MEEMM delivery.

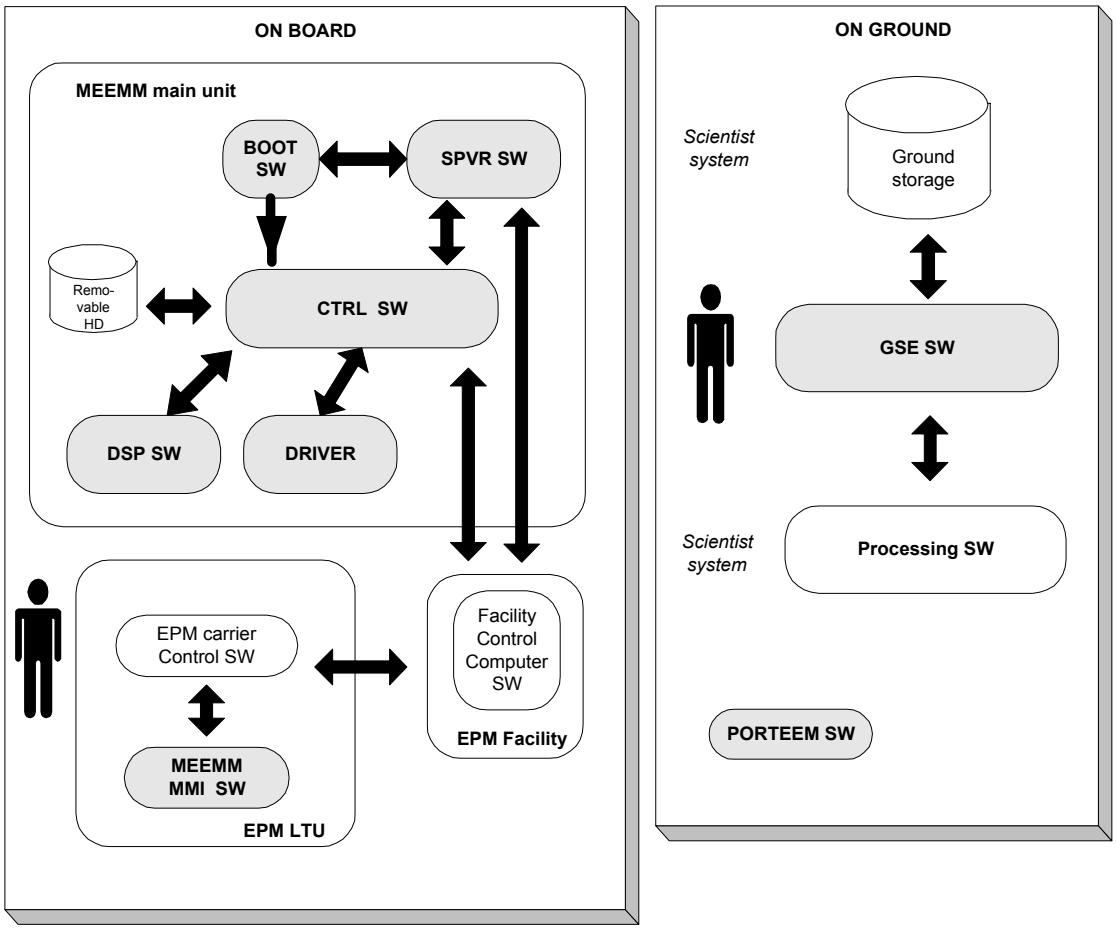


Figure 18 : On board / on ground SW definition

The MEEMM computer software items include :

Abbreviation	***Role***	***Runs on***
CTRL/DSP SW DRIVER	Control SW (CPU) and Head box Data Acquisition SW (DSP)	CPU board and DSP boards
SPVR SW BOOT SW	Supervision and House Keeping	Supervisor Board micro-controller
MMI SW	Man Machines Interface	EPM LTU
GSE SW	MEEMM Ground support SW	EPM carrier GSE
PORTEEM SW (not represented on the scheme on EPM LTU)	PORTEEM application Signal quality check before recording	EPM LTU EPM carrier GSE

The DSP SW acquires data from the heabox and read triggers information from the trigger connector. The CTRL SW gets these data. The data are stored on disk, and processed to be displayed on MMI SW and sent on ground if tele operation is required.

The SPVR SW receives TC from the carrier. TC addressed to CTRL SW are forwarded. It also acquires current, temperature information and fulfills the HK frame. Additionally, the HK frame is completed with information coming from CTRL SW.

The MMI SW receives data to be displayed and screen layout definition.
The data coming from PORTEEM and digital camera can be read on the LTU using LTU flash file reader and sent back to the CTRL SW using EPM services.

The SW components are detailed in RD17 “EPM/MEEMM SW Architectural and Detailed Design Document”

The SW commands and the sequences of mode (except the SPVR SW) are described in a dedicated User Manual RD2 “EPM/MEEMM SW User Manual .
The SPVR SW commands are given in AD7 “MEEMM TM/TC Data definition”.

Additionally, in paragraph 4.3, an example of various MMI displays corresponding to a typical EEG scenario is given.

The PORTEEM SW is described in RD23 “Columbus User’s manual”.

3.2.3 GSE ITEMS

This paragraph describes the complete MEEMM GSE configuration. According to specific model needs, the GSE can include a subset of the following items (refer to RD24 “Delivery Item List”).

3.2.3.1 Items and electronics circuits

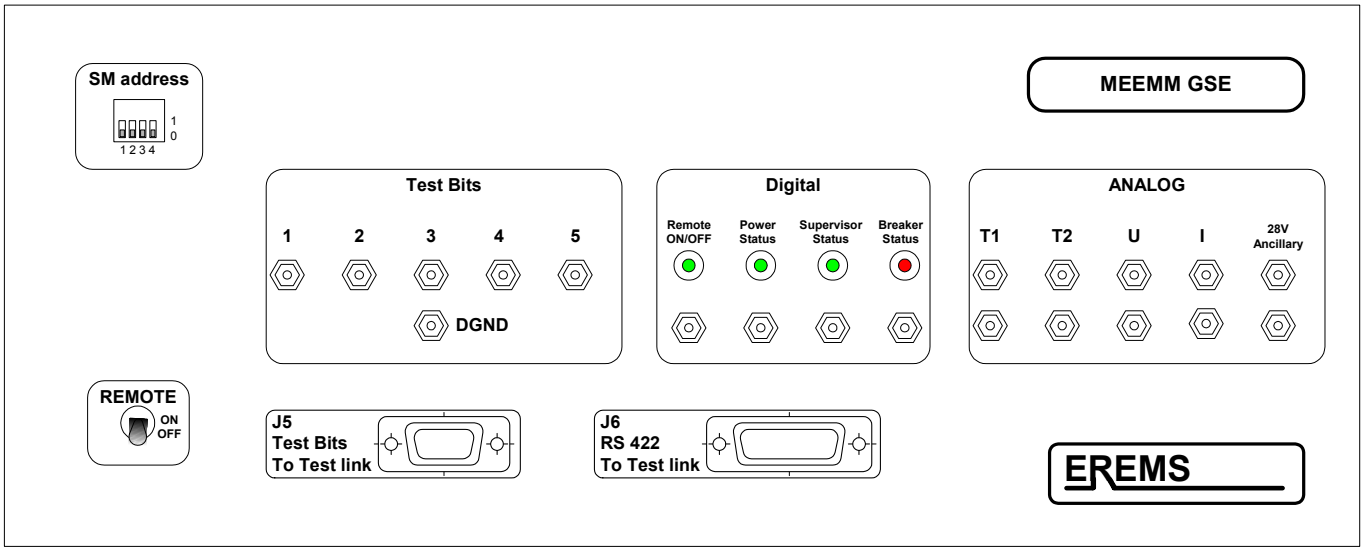
3.2.3.1.1 MEEMM GSE main box

The GSE main box internal components are the followings :

Qty	Description	Reference	Manufacturer
1	Box	Propac 3U63FP376 Ref appro:10850-021	SCHROFF
4	Box element	Profil avant 63F Ref appro: 30818-094	SCHROFF
1	Box element	Vis fixation Ref appro: 21101-416	SCHROFF
1	Box element	Face avant 3U63F Ref appro: 20850-136	SCHROFF
1	Box element	Panneaux arrière Ref appro: 20850-366	SCHROFF
1	28V Power supply	VEGA450V402YJT (V4QST 28B 5S)	LAMBDA
1	Ethernet Switch	PEAB-SW5M	PEABIRD
1	5V Power supply	ZWS5-5	LAMBDA
1	1 Status board	CDL/1.1721 001/ERE 1/A	EREMS

Table 5 : GSE main box internal components

The GSE main box front panel components are the followings :



Qty	Description	MEEMM use
1	4 Switches Dip 8	SM address positioning
1	Switch 5636 from APEM	Remote ON/OFF
1	Sub-D 9 S	J5 Test Bits
1	Sub-D 15 S	J6 RS422 Test Link
3	Green Led	Digital I/O indicator (Remote,Power, SVPR)
1	Red Led	Digital I/O indicator (Breaker trip status)
20	2mm Banana socket (panel isolated)	Test points for - Digital I/O (1,2,3,4) - Test bits (1,2,3,4,5,DGND) - Analog (T1 (PWR block)/T2 (Front panel)/U/I/Ancillary and associated return))

Table 6 : GSE main box front panel components

The GSE main box rear panel components are the followings :

Qty	Description	MEEMM use
1	J1 Sub-D 50S	MEEMM Data connector DPKA 131
1	J2 Sub-D 50P	GSE PC Acksys (RS links simulation unit) connector (Sub-D HD 62pts)
1	J3 Sub-D 15P	GSE PC Acksys (RS links simulation unit) connector (Sub-D HD 62pts)
1	J4 Sub-D 9S	Cooling system
3	4mm Banana socket (panel isolated)	For MEEMM Power connector DPKA
1	Shaffner	Main switch
1	Ethernet switch access	MEEMM LAN

Table 7 : GSE main box rear panel components

3.2.3.1.2 MEEMM GSE PC

The GSE PC internal components are the followings (except classical PC components):

Qty	Description	Reference	Manufacturer
1	Analog generator board	PCI-6711	National Instruments
1	RS links generator	8RSPCI-400	Acksys

3.2.3.1.3 MEEMM GSE attenuator box

This box is manufactured by EREMS and includes :
- a 80 dB attenuator based on resistors.
- A 1 to 3 BNC distribution of the analog signal

3.2.3.1.4 MEEMM GSE analog generator interface box

This box is built from a commercial equipment : National Instruments BNC-2110.

3.2.3.2 Interface functions

3.2.3.2.1 MEEMM GSE main box

The interfaces are provided in paragraph 3.2.3.1.1. Refer to RD27 “Interface Control Document”.for connector pin out

3.2.3.2.2 MEEMM GSE PC

Analog generator board : Dedicated NI board connector (Refer to RD27 “Interface Control Document”.for connector pin out)
RS links generator : 62 points SUBD connector (Refer to RD27 “Interface Control Document”.for connector pin out)
Adaptor for MEEMM HD : 37 points SUBD connector (Refer to RD27 “Interface Control Document”.for connector pin out)

3.2.3.2.3 MEEMM GSE attenuator box

Inputs : BNC connector
Outputs : 3 BNC interfaces and 12 2mm sockets (+, -, GND)

3.2.3.2.4 MEEMM GSE analog generator interface box

Inputs : Dedicated NI board connector (Refer to RD27 “Interface Control Document”.for connector pin out)
Outputs : DAC0 OUT to DAC03 OUT BNC interface and Digital output TTL SUBD 25 (Refer to RD27 “Interface Control Document”.for connector pin out)

4 OPERATING INSTRUCTIONS

4.1 MEEMM EXPERIMENT SCENARIOS

4.1.1 GENERAL

The types of experiments are very different one from the other on the configuration which is required, e.g.: Sleep & Ambulatory studies need a portable unit, brain stem are carried with only one electrode fixed on top of the skull, long latencies are carried with up to 128 electrodes but with a much lower bandwidth, etc...

Those various types of experiments are possible with MEEMM thanks to its modularity of equipments which allow the following configurations (refer to RD18 “EPM/MEEMM Operational Analysis Report”) :

Scenario	Characteristics	Average number of sessions per increment
1	**UP TO 64 CHANNELS BW: 0.01 HZ TO 580 HZ** (bipolar channels at headbox input interface)	**5 sessions/increment**
1/A	Middle/long latency EP on 32 channels	▪ 2
1/B	Middle/long latency EP on 64 channels	▪ 3
1/C	Raw EEG on 32 channels	▪ 0 (1)
1/D	Surface EMG on up to 32 channels (64 electrodes)	▪ 0 (2)
2	**128 CHANNELS BW: 0.01 HZ TO 580 HZ** (bipolar channels at headbox input interface)	**3 session/increment**
2/A	Middle/long latency EP on 128 channels	▪ 3
3	**32 CHANNELS BW: 1 HZ TO 10 KHZ** (bipolar channels at headbox input interface)	**3 sessions/increment**
3/A	Short/middle latency EP on 1 to 32 channels	▪ 1
3/B	Surface EMG on 32 channels (64 electrodes)	▪ 2
4	**16 channels Sleep & ambulatory**	**2 sessions/increment**
4/A	16 channels Sleep & ambulatory	▪ 2

Table 8 : MEEMM experiment scenarios

(1) Raw EEG without stimuli will probably be acquired most of the time with using the PORTEEM (configuration 4)
(2) Surface EMG will probably be acquired most of the time with using the HHB (configuration 3)

The choice between those different modes will be made by :

- The selection of the appropriate hardware by the operator
- The configuration, or the choice of the profile file, by operator of the MEEMM through the Man Machine Interface Software

Other modes could be possible with MEEMM equipments, especially some combinations between the number of EEG/EP and of EMGs, for instance:

- simultaneous acquisition with the LHBs of 96 EEG channels with 32 EMG channels
- or simultaneous acquisition with the LHBs of 64 EEG with 32 EMG or
- or simultaneous acquisition with the HHB of 16 EEG with 16 EMG channels
- etc.

Many possibilities are thinkable: they have not been planned here as each of them would require additional resources in terms of sensor sets and harnesses.

Notes:

1) *The combination consisting in using simultaneously both the HHB and the LHB(s) is not allowed.*
2) *The MEEMM SM has to be re-initialised (Main ON/OFF switch or RESET button) when changing of acquisition configuration : either LHB or HHB acquisition, either analog channels acquisition or not….)*

4.1.2 HARDWARE ITEMS – SELECTION ACCORDING TO RMS

For each configuration & mode described in Table 8 : MEEMM experiment scenarios, the required items for one session are shown in the following tables :

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

1/A	Up to 64 channels
	BW: 0.01 Hz to 580 Hz
		Middle/Long Latency EP on 32 channels	• Electronic equipments:
			  ○ Main Unit
			  ○ LHB1 or LHB2
			• Harnesses:
			  ○ 1 Harness EEG-32-LHB
			  ○ Harness LHB-data1
			  ○ Harness HB-power1
			• One sensor subset & consumables:
			  ○ One 32 Electrodes cap (sized to the astronaut head)
			  ○ 2 filled syringes
			  ○ Grass cream
			  ○ Cleaning wipes
			  ○ Adhesive tape
			• Harddisk (part of capacity)
			• Digitizing unit:
			  ○ Camera
			  ○ Harness-camera
			  ○ Compact Flash disk
			  ○ Compact Flash disk adaptor
			  ○ Scale ruler
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Stimulation/triggering source (e.g HRF TBC)
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection
			  • Humid cloths for head cleaning

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

1/B	Up to 64 channels
	BW: 0.01 Hz to 580 Hz
		Middle/Long Latency EP on 64 channels	• Electronic equipments:
			  ○ Main Unit
			  ○ LHB1 or LHB2
			• Harnesses:
			  ○ 2 Harnesses EEG-32-LHB
			  ○ Harness LHB-data1
			  ○ Harness HB-power1
			• One sensor subset & consumables:
			  ○ One 64 Electrodes cap (sized to the astronaut head)
			  ○ 4 filled syringes
			  ○ Cleaning wipes
			  ○ Grass cream
			  ○ Adhesive tape
			• Harddisk (part of capacity)
			• Digitizing unit:
			  ○ Camera
			  ○ Harness-camera
			  ○ Compact Flash disk
			  ○ Compact Flash disk adaptor
			  ○ Scale ruler
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Stimulation/triggering source
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection
			  • Humid cloths for head cleaning

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

1/C	Up to 64 channels
	BW: 0.01 Hz to 580 Hz
		Raw EEG on 32 channels	• Electronic equipments:
			  ○ Main Unit
			  ○ LHB1 or LHB2
			• Harnesses:
			  ○ 1 Harness EEG-32-LHB
			  ○ Harness LHB-data1
			  ○ Harness HB-power1
			• One sensor subset & consumables:
			  ○ One 32 Electrodes cap (sized to the astronaut head)
			  ○ 2 filled syringes
			  ○ Grass cream
			  ○ Cleaning wipes
			  ○ Adhesive tape
			• Harddisk (part of capacity)
			• Digitizing unit:
			  ○ Camera
			  ○ Harness-camera
			  ○ Compact Flash disk
			  ○ Compact Flash disk adaptor
			  ○ Scale ruler
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection
			  • Humid cloths for head cleaning

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

1/D	Up to 64 channels
	BW: 0.01 Hz to 580 Hz
		Surface EMG on up to 32 channels (64 electrodes)	• Electronic equipments:
			  ○ Main Unit
			  ○ LHB1 or LHB2
			• Harnesses:
			  ○ 1 Harness EMG-16 or EMG-32
			  ○ Harness LHB-data1
			  ○ Harness HB-power1
			• One sensor subset & consumables:
			  ○ Up to 32 pairs of one-use snapping electrodes
			  ○ Cleaning wipes
			• Harddisk (part of capacity)
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

2/A	128 channels
	BW: 0.01 Hz to 580 Hz
		Middle/Long Latency EP on 128 channels	• Electronic equipments:
			  ○ Main Unit
			  ○ LHB1 and LHB2
			• Harnesses:
			  ○ 4 Harnesses EEG-32-LHB
			  ○ Harness LHB-data2
			  ○ Harness HB-power2
			• One sensor subset & consumables:
			  ○ One 128 Electrodes cap (sized to the astronaut head)
			  ○ 8 filled syringes
			  ○ Grass cream
			  ○ Cleaning wipes
			  ○ Adhesive tape
			• Harddisk (part of capacity)
			• Digitizing unit:
			  ○ Camera
			  ○ Harness-camera
			  ○ Compact Flash disk
			  ○ Compact Flash disk adaptor
			  ○ Scale ruler
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Stimulation/triggering source
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection
			  • Humid cloths for head cleaning

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

3/A	32 channels
	BW: 1 Hz to 10 kHz
		Short/Middle latency EP on 1 to 32 channels	• Electronic equipments:
			  ○ Main Unit
			  ○ HHB
			• Harnesses:
			  ○ 1 Harness EEG-32-HHB
			  ○ Harness HHB-data
			  ○ Harness HB-power1
			• One sensor subset & consumables:
			  ○ One 32 Electrodes cap sized to the astronaut head (1)
			  ○ 2 filled syringes
			  ○ Grass cream
			  ○ Cleaning wipes
			  ○ Adhesive tape
			• Harddisk (part of capacity)
			• Digitizing unit:
			  ○ Camera
			  ○ Harness-camera
			  ○ Compact Flash disk
			  ○ Compact Flash disk adaptor
			  ○ Scale ruler
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Stimulation/triggering source
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection
			  • Humid cloths for head cleaning

(1) for short latencies, only one or 2 electrodes are necessary. Nevertheless, in order to avoid complementary fixing materials such as Collodion, we plan to use a complete cap, only the useful electrodes will be filled with gel.

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

3/B	32 channels
	BW: 1 Hz to 10 kHz
		Surface EMG on up to 32 channels (64 electrodes)	• Electronic equipments:
			  ○ Main Unit
			  ○ HHB
			• Harnesses:
			  ○ 1 Harness EMG-16 or EMG-32
			  ○ Harness HHB-data
			  ○ Harness HB-power1
			• One sensor subset & consumables:
			  ○ Up to 32 pairs of one-use snapping electrodes
			  ○ Cleaning wipes
			• Harddisk (part of capacity)
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Crew support equipments
			  • Subject restrainers
			  • Trash collection

Config / Mode Number	Configuration Characteristics	Mode characteristics	Required Items

4/A	16 channels
	BW: 0,3 Hz to 150 Hz
		Sleep & ambulatory with:
		• 12 EEG channels (BW:0,3-70Hz)
		• 2 EMG channels (BW:1-150Hz)
		• 1 ECG channels (BW:1-150Hz)
		• 1 strain gauge respiration channel (BW:0,3-30Hz)
			• Electronic equipments:
			  ○ PORTEEM
			• Harnesses:
			  ○ Harness PORTEEM
			• One sensor subset & consumables:
			  ○ One 12 Electrodes cap (sized to the astronaut head)
			  ○ 1 filled syringe
			  ○ Grass cream
			  ○ EMG, ECG, strain gauge sensors
			  ○ Cleaning wipes
			  ○ Adhesive tape
			• Compact Flashdisk and adaptor
			• 4 AA batteries
			• External equipments (not part of MEEMM delivery):
			  ○ LTU for MMI SW
			  ○ Crew support equipments
			  • Equipment restraints for PORTEEM (Bag or Velcro)
			  • Trash collection
			  • Humid cloths for head cleaning

4.2 CREW OPERATING TASKS

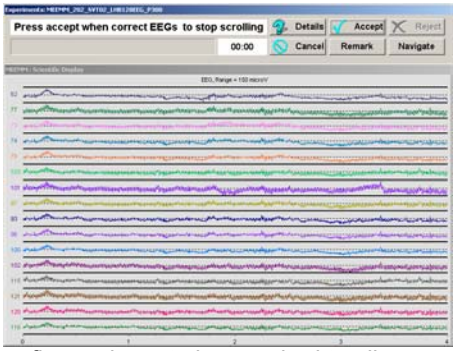
4.2.1 PRE-INCREMENT, INCREMENT & POST-INCREMENT TASKS

4.2.1.1 Pre-increment tasks

Pre-increment tasks include all the tasks to be performed on ground, with the astronaut, the hardware and the software before launch.
This paragraph is divided into 3 parts :

- Crew preparation
- HW preparation
- SW preparation

4.2.1.1.1 Crew preparation:

Tasks	**Steps**	**Recommendations Do/Don't Tips**
Choice of the Test Subject	The selection of the subject can not be separated from scientific preliminary tests to check the good behaviour of each subject : - Correct impedances - Low muscle activity - Correct behaviour to scientific stressors	The subject shall not be bald (bad impedance due to the tanned skin). No gel on subject hair
Training to operating of MEEMM	The subject and the operator shall be trained on : - HW connection - Reference points marking - Cap installation (gel injection, impedance checking) - SW interface - Scientific curves appreciation (with help of subject ground proper responses)	The most critical training is the operator one for the cap installation and the gel injection. A minimum of two cap installations are required to get a correct feeling for the gel injection.
Baseline Data Collection on the Test Subject	Subject typical ground responses are required to help the operator to appreciate the subject response on board. During Baseline Data collection : - screen copies have to be done of EEG and EP (if any) responses.  - impedance figures have to be acquired to allow correct configuration on session profile (refer to paragraph 4.2.1.1.3).	Screen copies can be attached to on board procedures in a removable appendix to allow the operator to fix it next to the LTU screen. Some tips can be added on these pages to help the operation to asses the curves : - eyes artefact visualising - noise level compared to selected scale (To be completed with scientists during collection)
Marking of fiducial reference Landmarks (optional, only is	3 reference marks are required for photogrammetry purpose : Nasion, Left preauricular and Right preauricular points.	

Tasks	Steps	Recommendations Do/Don't Tips
photogrammetry is planned)	The purpose of this task is to take pictures of the astronaut with these reference marks to help the operator to mark the subject on board. The 3 reference points marking is done using dermatological pen.  Figure 19 : dermatological pen	
	The marking can be done using anatomical structures or using MRI (according to required precision and scientific application).	
	Take one photograph of each side of the subject to be sure that each of the 3 marks are clearly visible on the set of photographs (zoom preferred)  Figure 20 : Photograph of test subject with marked reference points	Pictures and zooms can be attached to on board procedures in a removable appendix to allow the operator to fix it on the EPM rack front panel while marking the points on the subject. Some tips can be added on these pages to help the operation to mark the points : - subject inner marks

4.2.1.1.2 Hardware preparation

Tasks	Steps	Recommendations Do/Don't Tips
Choice of the flight caps	The set of cap that will be used for the increment has to be chosen in accordance with the size of the Subject Head and with the number of electrodes required for the requested number of channels	The scientific session duration has to be taken into, account in the cap size selection. The impedances will be lower with an adjusted cap but the subject comfort will be lower. Trade off to be done according to the scientific session duration
Preparation of the consumables	To be done according the increment scenario and the consumables available on board and their life time. At least the syringes with gel have to be replaced at each increment. For the other consumables (Batteries, EMG electrodes, Grass cream, Adhesive roller, Dermatological pen, Alcohol wipes), the on board availability and their life time have to be checked.	Increase the number of syringes used on ground by twice, at least for the first increments to take into account potential increased gel consumption on board. The planned 7 syringe boxes covers largely this recommendation.

Tasks	Steps	Recommendations Do/Don't Tips
Camera calibration	Camera Calibration is the process of determining the characteristics of a camera so it can be used for the photogrammetry, using PhotoModeler SW. The calibration results will be injected in PhotoModeler SW during post increment tasks for the digitising post processing tasks. This task has to be done once, before the first use of the camera for photogrammetry. Refer to RD26 "EPM/MEEMM 3D Electrodes Modelling User Manual" for detailed operation linked to the camera calibration (paragraph 4.1).	
Camera packing	Camera is to be packed inside transparent bag in order to be examined for glass splinters by the crew before the first unpacking after launch.	
HD selection	HD are formatted before each new increment to included appropriate increment profiles and SWs. (Refer to paragraph 4.2.1.1.3 for associated operations). The number of disks have to be done according to the RMS	
Compact Flashdisk selection	The number of Compact flashdisks have to be done according to the RMS. Compact flasdisks shall be pre-formatted and checked for being empty (without any PORTEEM or photos files).	

4.2.1.1.3 Software preparation

Tasks	Steps	Recommendations Do/Don't Tips

Profile generation	Profiles are files allowing to configure MEEMM and to define screens to be displayed by the MMI.
	One profile is defined and stored on MEEMM HD for each experiment session. A profile includes the main following parameters :
	- Recording configuration
	  ○ The headbox to be used
	  ○ The name of processing and stored channels
	  ○ Acquisition chain gains
	  ○ Recording sequence length (for HD management)
	  ○ ADC sample frequency
	  ○ External stimuli mode (associated 8-bit code events)
	- Processing parameters
	  ○ Choice of stimuli code(s) for on board EP calculation
	  ○ EP pre and post stimuli latency (in ms)
	  ○ Level of artefact filtering with period of filtering
	  ○ FFT calculation parameters
	  ○ Impedance threshold according to subject characteristics
	- Mode and screens sequence
	  ○ Impedance
	  ○ Calibration
	  ○ Recording
		New profiles shall be written from the Typical profiles associated to MEEMM referenced scenario.

Tasks	Steps	Recommendations Do/Don't Tips
	○ EEG, EP, FFT screens - Display set-up ○ Choice of default channels in each display screen (16 channels max by display screen) ○ Display period ○ Amplitude Profiles format are described in details in RD2 "EPM/MEEMM SW User Manual" (paragraph 7.1). Typical profiles associated to MEEMM referenced scenario given in paragraph 4.1 are provided in RD2 "EPM/MEEMM SW User Manual" (paragraph 7.2).	
HD preparation	Before each increment, the HD(s) content has to be updated with required SW versions and selected profiles. This operation is divided into 2 parts : 1) Creation of a MEEMM HD from an image with the correct SW versions (refer to RD2 "EPM/MEEMM SW User Manual" (paragraph 8.6). 2) Upgrade of the profiles with the ones required for the next increment (refer to RD2 "EPM/MEEMM SW User Manual" (paragraph 8.5). Note : At EPM level, the IAP and GCP shall also be upgraded according to new profiles.	

4.2.1.2 Increment tasks

They will include:

- Beginning of increment (to be described with Columbus environment):
  - Reception & Stowage of the newly uploaded consumables
  - Before unpacking of the camera after launch, examination through transparent bag that there are no glass splinters.

- For each session in increment (refer to associated procedures in paragraph 4.2.2)
  - Session Preparation (HD exchange, HW set-up, optional calibration)
  - Data acquisition on subject & recording
  - Pack-Up (including HD)

- End of Increment (to be described with Columbus environment) :
  - Sorting of the used consumables
  - Possible Preventive Maintenance tasks
  - Downloading of the used consumables
  - Downloading of the Data Harddisks & Flashdisks

4.2.1.3 Post-increment tasks

Post-increment tasks include all the tasks to be performed on ground, with the astronaut, the hardware and the software after the increment.
This paragraph is divided into 3 parts :

- Crew tasks
- HW tasks
- SW tasks

4.2.1.3.1 Crew tasks:

Tasks	Steps	Recommendations Do/Don't Tips
Optional - Baseline Data Collection on the Test Subject	Same steps as for the pre-increment Baseline Data collection.	

4.2.1.3.2 HW tasks:

Tasks	Steps	Recommendations Do/Don't Tips
Caps reception	The set of cap that have been used during the increment has to be cleaned on ground. - Unsnap and remove the straps, place to one side and wash them with a brush and soapy water. - Fill sink with tap water - Add a small amount of Ivory liquid detergent to the water - Submerge only the cap (not the connector) - Let the cap in the water a few minutes to a few hours - Clean the gel from the electrode mounts with a cotton swab. Another method is to alternate each mount, in turn, under rapidly running water. - Rinse the cap thoroughly - Blot the cap gently in a terry cloth towel or hang it up to dry so that the cap is lower than the connector. - When the cap is dry, replace the straps	Use only IVORY or PALMOLIVE liquid detergent for washing the EEG cap. The cap can be left on the water (with Ivory liquid) a few hours before the cleaning operations (less than 6 hours). Do not wash different colored caps together. Oxide gradually builds up on the electrode disks and should be periodically scraped away. The metal electrode disks can be scraped with the wooden end of a cotton swab.
Consumables reception	The syringes have to be cleaned with water and place within the box. Clean the boxes if required. Put in dedicated trash containers the other consumables (Batteries, EMG electrodes, Grass cream, Adhesive roller, Dermatological pen, Alcohol wipes).	
Photo post-processing	Photomodeler SW is used to get electrode localisation Refer to RD26 "EPM/MEEMM 3D Electrodes Modelling User Manual" for detailed operation linked to the Photo post-processing.	
HD reception	A complete image of the HD(s) is created for full backup of the HD for initial archive use ((refer to RD2 "EPM/MEEMM SW User Manual" (paragraph 8.7)) Once the data are transferred to the archiving system, the following information can be extracted : - Photos files to be processed by Photomodeler SW - Calibration data (refer to RD2 "EPM/MEEMM SW User Manual" (paragraph 7.3.3)). - Impedance data (refer to RD2 "EPM/MEEMM SW User Manual" (paragraph 7.3.3)). - Raw files to be converted to SCAN4 files (refer to RD2 "EPM/MEEMM SW User Manual" (paragraph 7.3.4)) before scientific post processing with a dedicated SW.	
Flashdisk reception	The raw scientific data shall be extracted from the PORTEEM flashdisks. - Insert each flashdisks in a laptop - Transfer the raw scientific files in proper directories on the MEEMM GSE PC - Extract the PORTEEM raw files to standard formats proposed by the PORTEEM SW (refer to RD23 "Columbus User's	

Tasks	Steps	Recommendations Do/Don't Tips
	manual) and transfer them to archiving system equipped with scientific post processing SW.	

4.2.1.3.3 SW tasks:

Tasks	Steps	Recommendations Do/Don't Tips
EEG/EMG data scientific post processing SW	Exploitation of Results by the Scientists EEG/EMG experiment raw data to be processed using dedicated post-processing SW. Steps are a specific scientific tasks.	The electrode placement is described in RD28 "EPM/MEEMM EEG cap specification". Especially for the 128 EEG electrode cap, a few electrodes are shifted from the theoretical placement described in the document due to the output of the wires on the tissue. For mapping operations, this point shall be corrected using photogrammetry results.

4.2.2 EXPERIMENT PROCEDURES

Two different preliminary procedures corresponding to the Flight operations have been defined, each procedure being associated to a specific experiment type involving dedicated hardware :

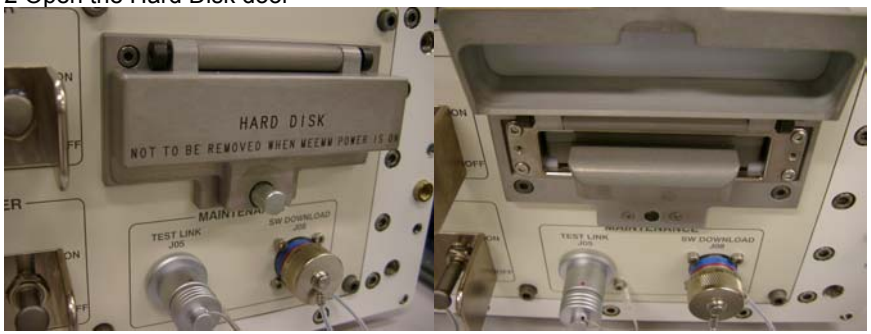
- Stationary procedure corresponding to the following experiments (listed in paragraph 4.1.1) :
  - Raw EEG on up to 32 channels (64 is possible but has no scientific interest)
  - Middle / long latency EP on up to 64 channels
  - Surface EMG on up to 32 channels with EMG BW limited to 580 Hz
  - Middle / long latency EP on up to 128 channels
  - Short / Middle latency EP on up to 32 channels (usually need only on 1 or 2 channels for short latency studies)
  - Surface EMG on up 32 channels with EMG BW limited to 10 kHz
- Ambulatory and sleep procedure corresponding to Sleep & Ambulatory studies

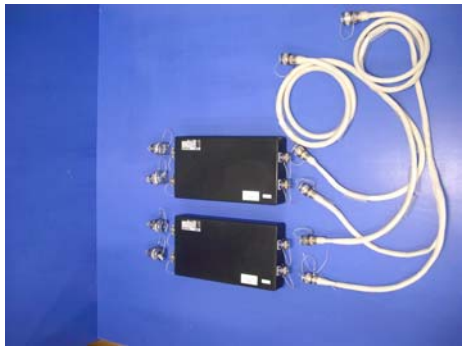
Those procedures only concern nominal flight operation of MEEMM for acquisition. They show the different steps for the operation of MEEMM associated with its 2 main types of utilisation.
According to the type of experiments, some procedure steps will be different mainly at the following levels :

- Type of required headbox (1 LHB, 2 LHBs, HHB)
- Type of sensors (EEG, Surface EMG)
- Type of scientific application (external triggering or no triggering)

4.2.2.1 Stationary procedure

Step	Task	Crew concerned
	PREPARATION AND MONITORING STEPS	A, B
1	EPM/LTU switched ON	A or B
2	MEEMM MMI use	A or B
2.1	1. Selection of MEEMM experiment interface on the LTU	A or B
2.2	2. Take information on Hardware configuration (headbox, harness to choose, Harddisk SN)	A or B

3	Destowage of harddisk (MEEMM HARD DISK) with the serial number issued from step 2.2 Insertion of Harddisk in Main Unit 1 Check that the MEEMM main Unit is powered OFF (POWER LED turned off, POWER SWITCH not in ON position) 2 Open the Hard Disk door  3. Remove and stow the hard disk 4. Insert the new hard disk 5. Close the Hard Disk door (the closing of the door ensures a correct positioning of the HD) 6. The door is correctly closed when the black plastic is no more visible on the door lock	A or B
4	In case of applications involving averaging markers (e.g. EPs) : Connexion of external stimulation/triggering source to the MEEMM front panel	A or B
5	Destowage of Headbox(es)	A or B
	In case of low frequency application with less than 64 channels :	In case of low frequency application with 64 to 128 channels :	In case of high frequency application :
5.1	Destowage of MEEMM LOW FREQUENCY HEADBOX1 (LHB1) item	Destowage of MEEMM LOW FREQUENCY HEADBOX1 (LHB1) item and MEEMM LOW FREQUENCY HEADBOX2 (LHB2) item	Destowage of MEEMM HIGH FREQUENCY HEADBOX1 (HHB) item	A or B
6	Destowage of Appropriate Harness	A or B

	In case of low frequency application with less than 64 channels :	In case of low frequency application with 64 to 128 channels :	In case of high frequency application :	
6.1	Destowage of Harnesses (MEEMM LHB DATA1 HARNESS, MEEMM HB POWER1 HARNESS)	Destowage of Harnesses (MEEMM LHB DATA2 HARNESS, MEEMM HB POWER2 HARNESS) 	Destowage of Harnesses MEEMM HHB DATA HARNESS, MEEMM HB POWER1 HARNESS 	A or B

7	Connect the end P1 of MEEMM LHB DATA1 HARNESS to MEEMM MU front panel HEADBOX DATA LHB J01 Connect the end P2 of MEEMM LHB DATA1 HARNESS to MEEMM LOW FREQUENCY HEADBOX1 (LHB1) DATA J04 connector Connect the end P1 of MEEMM HB POWER1 HARNESS to MEEMM MU front panel HEADBOX HEADBOX POWER J02 Connect the end P2 of MEEMM HB POWER1 HARNESS to MEEMM LOW FREQUENCY HEADBOX1 (LHB1) POWER J03 connector	Connect the end P1 of MEEMM LHB DATA2 HARNESS to MEEMM MU front panel HEADBOX DATA LHB J01 Connect the end P2 of MEEMM LHB DATA2 HARNESS to MEEMM LOW FREQUENCY HEADBOX1 (LHB1) DATA J04 connector Connect the end P3 of MEEMM LHB DATA2 HARNESS to MEEMM LOW FREQUENCY HEADBOX2 (LHB2) DATA J04 connector Connect the end P1 of MEEMM HB POWER2 HARNESS to MEEMM MU front panel HEADBOX HEADBOX POWER J02 Connect the end P2 of MEEMM HB POWER2 HARNESS to MEEMM LOW FREQUENCY HEADBOX1 (LHB1) POWER J03 connector Connect the end P3 of MEEMM HB POWER2 HARNESS to MEEMM LOW FREQUENCY HEADBOX2 (LHB2) POWER J03 connector	Connect the end P1 of MEEMM HHB DATA HARNESS to MEEMM MU front panel HEADBOX DATA HHB J03 Connect the end P2 of MEEMM HHB DATA HARNESS to MEEMM HIGH FREQUENCY HEADBOX (HHB) DATA J03 connector Connect the end P3 of MEEMM HHB DATA HARNESS to MEEMM HIGH FREQUENCY HEADBOX (HHB) DATA J04 connector Connect the end P1 of MEEMM HB POWER1 HARNESS to MEEMM MU front panel HEADBOX HEADBOX POWER J02 Connect the end P2 of MEEMM HB POWER1 HARNESS to MEEMM HIGH FREQUENCY HEADBOX (HHB) POWER J02 connector	A or B
8	Fixation of Headboxes on the EPM rack front panel			A or B
9	Switch-on Main Unit (POWER SWITCH in ON position or in REMOTE position)			A or B
10	*Optional step* *Calibration of the chain by MEEMM Main unit (with storage of the calibration coefficients with the session data file)*			A or B

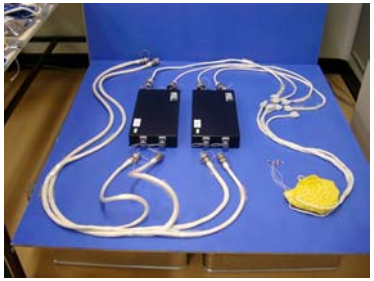
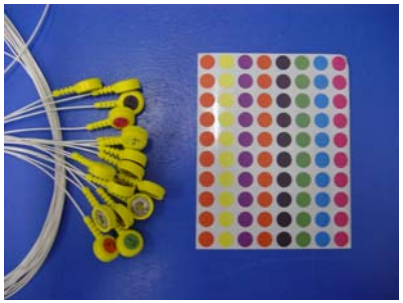
10.1	De-stow 2 MEEMM Headbox Calibration plug (MEEMM HB CAL PLUG) Connect them to the MEEMM LOW FREQUENCY HEADBOX1 J01 and J02. Selection of MEEMM_201_CAL_LHB64 GCP on the LTU Follow the GCP instructions At the end of the GCP, disconnect the MEEMM Headbox Calibration plugs (MEEMM HB CAL PLUG) and stow them back in the stowage container	De-stow 4 MEEMM Headbox Calibration plug (MEEMM HB CAL PLUG) Connect them to the MEEMM LOW FREQUENCY HEADBOX1 J01 and J02 and to the MEEMM LOW FREQUENCY HEADBOX2 J01 and J02. Selection of MEEMM_202_CAL_LHB128 GCP on the LTU Follow the GCP instructions At the end of the GCP, disconnect the MEEMM Headbox Calibration plugs (MEEMM HB CAL PLUG) and stow them back in the stowage container 	De-stow 1 MEEMM Headbox Calibration plug (MEEMM HB CAL PLUG) Connect them to the MEEMM HIGH FREQUENCY HEADBOX J01. Selection of MEEMM_203_CAL_HHB32 GCP on the LTU Follow the GCP instructions At the end of the GCP, disconnect the MEEMM Headbox Calibration plug (MEEMM HB CAL PLUG) and stow them back in the stowage container	A or B
11	Session beginning - Installation of Test Subject : Selection of the required scientific GCP on the LTU. According to GCP interface, press OK when subject is installed In case of EEG application :		In case of EMG application :	A & B

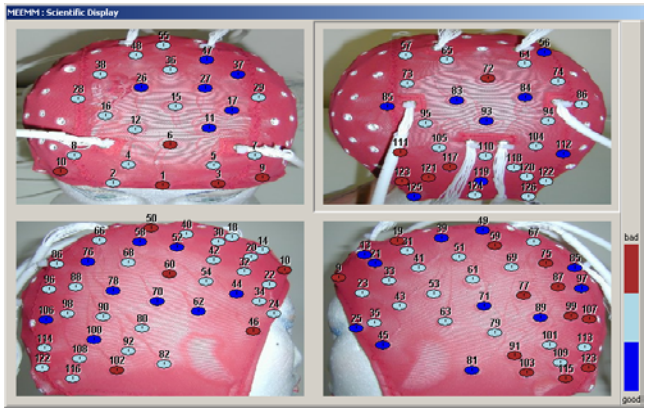
11.1	Installation of the test subject with the use of ISS foot and back restrainers To be completed when Columbus environment known				A & B
11.2	Destowage of subject photo with required landmarks (tragus left and right, nasion) and dermatological pen (MEEMM DERMATOLOGICAL PEN)	-			A & B
11.3	The operator has to mark the 3 reference points on the subject helped with the photo, with the temporary marker. Photos will be added showing the positioning of the subject, the operator and the equipment and inserted as tear out pages in the on board user manual.	-			A & B
11.4	Stow back the subject photo and the dermatological pen (MEEMM DERMATOLOGICAL PEN)	-			A & B
12	Destowage of appropriate sensor harnesses (connection), sensors and accessories (held by test subject)				A & B
	In case of 32 EEG cap application :	In case of 64 EEG cap application :	In case of 128 EEG cap application :	In case of EMG cap application :	
12.1	Destowage of cleaning wipes for ground, reference and EOG electrodes				A & B
12.2	Destowage of 32-electrode cap (MEEMM 32 EEG ELECTRODE CAP) and 1 syringe box (MEEMM SYRINGES BOX)	Destowage of 64-electrode cap (MEEMM 64 EEG ELECTRODE CAP) and 1 syringe box (MEEMM SYRINGES BOX)	Destowage of 128-electrode cap (MEEMM 128 EEG ELECTRODE CAP) and 2 syringe boxes (MEEMM SYRINGES BOX)	Destowage of EMG electrodes packets (MEEMM EMG SINGLE ELECTRODE) or (MEEMM EMG DUAL ELECTRODE)	A & B
12.3	Destowage of adhesive roller (MEEMM ADHESIVE ROLLER) and specific gluing cream (MEEMM SIGNA CREAM TUBE) for face individual electrodes			-	A & B
13	Preparation, mounting & functionality insurance of the electrode set. Installation time indication (RD18 “EPM/MEEMM Operational Analysis Report”) will be inserted in the procedures to guide the operator. For all steps of this task, photos will be added showing the positioning of the subject, the operator and the equipment and inserted as tear out pages in the on board user manual. These tear out pages will contain legend notes reminding the good tips related to the task.				A & B
	In case of EEG application :		In case of EMG application :		
13.1	1. Center the electrodes 1 and 2 on the subject forehead 2. The operator slip the cap onto the head by working the hands from the front to		-		A & B

	the back in a smooth motion. The operator is helped by the subject who held the cap on his forehead. 3. The subject attaches the chin straps helped by the operator 4. Determine that the cap is centred on the head, and that the subject is comfortable 5. The operator marks again the tragus landmarks on the cap tissue the dermatological pen (MEEMM DERMATOLOGICAL PEN), regards to the marks on the subject skin. 6. Stow back the dermatological pen (MEEMM DERMATOLOGICAL PEN) 7. The operator has to fix the cap harness on the subject shoulder using adhesive tape.		

13.2	The operator has to fix the cap individual electrodes on the subject face. Electrodes positions will be defined by photos and zooms on the electrodes colours (tear out pages).  For each individual electrode, the associated procedure is the following : 1. Clean the skin with cleaning wipes to eliminate all dead skins 2. Use the Grass cream to massage the skin 3. Fill the electrode cavity with Grass cream 4. Apply the electrode on the skin 5. Apply on the positioned electrode adhesive to fix the electrode and the wire	The subject gives to the operator the EMG electrodes extracted from the EMG electrodes packets (MEEMM EMG SINGLE ELECTRODE) or (MEEMM EMG DUAL ELECTRODE) and the cleaning wipes. For each individual electrode, the operator has to clean the skin for the electrodes and fix the electrodes (one by one or one pair by one pair according to the type of electrodes).	A & B
13.3	Throw used wipes in trash collector		A & B

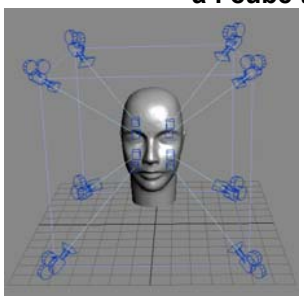
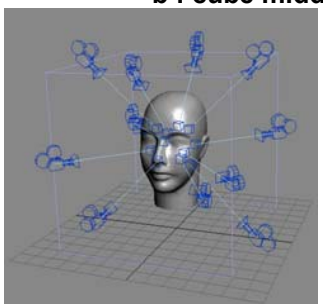
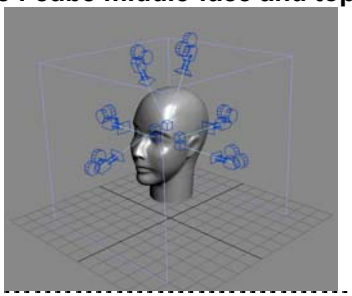
13.4	The operator has to fill each cap electrode cavity with gel : 1. Press the white mount against the scalp with the first and middle fingers of the left hand. 2. Hold the syringe with the other hand and insert the blunted needle into the hole. Lift the blunted needle off the scalp slightly 3. Inject the gel into the cavity until a small amount comes out the hole in the mount. 4. Hold the syringe with only the first finger of the right hand on the syringe plunger. 5. With a moderate amount of downward pressure, rock the syringe/needle rapidly back and forth. 6. Wipe out the excess gel with cleaning wipes. Note : once the gel is filled in all the cap electrodes, the impedances will improve themselves with the time. As a consequence, it is recommended to avoid lost time during impedance testing phase to perform MEEMM parallel tasks (e.g. stimulator operations….) during about 15 minutes.	-	A & B

13.5	De-stow Headbox/Cap harnesses (one to four MEEMM EEG32 LHB HARNESS for Low Frequency headbox or one MEEMM EEG32 HHB HARNESS for the High Frequency headbox). One harness is required by set of 32 electrodes on the cap.  According to the number of connector on the cap (set of 32 electrodes): Connexion of MEEMM EEG32 LHB HARNESS S/N 01 from P1 of MEEMM 128/64/32 EEG ELECTRODE CAP to EEG J01 connector on LHB headbox S/N 01 (MEEMM LOW FREQUENCY HEADBOX 1(LHB1)) Connexion of MEEMM EEG32 LHB HARNESS S/N 02 from P2 of MEEMM 128/64 EEG ELECTRODE CAP to EEG J02 connector on LHB headbox S/N 01 (MEEMM LOW FREQUENCY HEADBOX 1(LHB1)) Connexion of MEEMM EEG32 LHB HARNESS S/N 03 from P3 of MEEMM 128 EEG ELECTRODE CAP to EEG J01 connector on LHB headbox S/N 01 (MEEMM LOW FREQUENCY HEADBOX 2(LHB2)) Connexion of MEEMM EEG32 LHB HARNESS S/N 04 from P4 of MEEMM 128 EEG ELECTRODE CAP to EEG J02 connector on LHB headbox S/N 01 (MEEMM LOW FREQUENCY HEADBOX 2(LHB2)) or Connexion of MEEMM EEG32 HHB HARNESS on EEG J01 connector from P1 of MEEMM 32 EEG ELECTRODE CAP to HHB headbox (MEEMM HIGH FREQUENCY HEADBOX (HHB)) Follow the GCP instructions (use of the OK button) to go to the impedance test phase.	Destowage of Electrodes Harness(es) MEEMM EMG16 HB HARNESS or MEEMM EMG32 HB HARNESS depending on number of electrodes Connexion of the individual snapping buttons on the EMG electrodes already applied on the subject. The way to select the correct harness button for a selected EMG electrodes will be described using schemes or pictures (tear out pages).  Connexion of MEEMM EMG16 HB HARNESS or MEEMM EMG32 HB HARNESS harness on EEG J01 connector on LHB or HHB headbox	A & B
E10	1. Test Subject localises the incorrect electrodes with LTU display and announce them to operator.		

13.6	Verification of impedance values 1)Test subject localises the incorrect electrodes with the LTU display and announce them to the operator  2) Operator improves them with abrasion/gel 3) Acceptation ans storage of impedances values following GCP instructions.		
13.7	Stow back empty syringes in the syringes box and in stowage drawer The subject is ready for monitoring and recording phases	The subject is ready for monitoring and recording phases.	A & B
14	In case of applications involving averaging markers (e.g. EPs) : Configuration & Connexion of Stimuli Sources		A & B
14.1	1. Destowage & Configuration of Stimuli Source items(earspeakers, flashlights, response pads, etc.)		A & B
14.2	2. Connexion on trigger connector of Main Unit (EXTERNAL INPUTS/DIGITAL J04 connector)		A & B
14.3	3. Switch-On stimuli source		A & B

15	Operator takes back LTU	A & B
16	Quick monitoring display before acquisition (refer to paragraph 4.3.1), following the GCP instructions. Use the OK button to go from one step to the next one.	A & B
16.1	1. Display screens of EEG/EMG data (screens defined in the selected profile): ○ Quick look at EEG/EMG signal ○ Display screens of FFT data (screens defined in the selected profile)	A & B
16.2	2. In case of applications involving averaging markers (e.g. EPs) : verification of the stimuli acquisition	A & B

	RECORDING STEPS **PHOTOGRAMMETRY**		A B partially
17	The operator accepts the start of the recording (+ start of stimuli execution (in case of applications involving averaging markers (e.g. EPs))), following the GCP instructions. Use the OK button to go from one step to the next one.		A & B
18	Data recording, display by operator of the monitoring data (EEG, EP, EMG, FFT), following the GCP instructions. Use the OK button to go from one step to the next one. The operator checks correct session behaviour (criteria to be detailed by scientist and provided in on board procedures) The way to synchronise MEEMM recording and the stimulator in the operational point of view has to be discussed.		A B partially depending on stimuli type
19	Automatic stop of the recording and the acquisition after a defined period or at the end of of stimulation (in case of applications involving averaging markers (e.g. EPs))		A & B
20	Optional Impedance check at the end of the session		A & B
	In case of EEG application :	In case of EMG application :	
20.1	Operator accept impedance mode on LTU MMI and store the final impedances values following the GCP instructions.	-	A & B
21	In case of use of digitising tools : Electrode location picturing		A & B
21.1	1. Destowage of camera (MEEMM CAMERA), camera harness (MEEMM CAMERA HARNESS) & compact flash (MEEMM COMPACT FLASHDISK) and adaptor (MEEMM COMPACT FLASH ADAPTER), scale ruler (MEEMM SCALE RULER) 2. Camera is packed inside transparent bag and has to be examined for glass splinters (lens, flash, display and view finder) by the crew before the first unpacking after launch		A & B

21.2	3. Insertion of compact flash (MEEMM COMPACT FLASHDISK) 4. Connection of camera Harness (MEEMM CAMERA HARNESS) to main Unit Front Panel (CAMERA POWER J06) and to Camera (MEEMM CAMERA J01) (to be done by the operator to avoid arc discharge at camera level) 5. Switch ON the CAMERA POWER SWITCH on the MEEMM front panel (to be done by the operator to avoid arc discharge at camera level) 6. The operator switches ON the camera 7. Fix the scale ruler on the subject cap using the dedicated velcro.	A & B
21.3	8. Camera configuration and photos ○ The steps to configure the camera and to take the photos are described in RD26 “EPM/MEEMM 3D Electrodes Modelling User Manual” ○ The principle is to take consider the head as a cube (25 photograph to have a complete cover of the head),: **-a : cube tops**  **-b : cube middle-edges**  **-c : cube middle-face and top** 	A & B

21.4	9. Transfer from camera to LTU : ○ De-insert compact flash disk from camera ○ Using adaptor, insert in LTU ○ Transfer Pictures from Flashdisk to LTU ○ Wait for Acknowledge from LTU for the picture correct transfer ○ De-insert flashdisk ○ Stow back flash-disk, adaptor and camera	A & B
	Automatic Transfer from the LTU to MEEMM Main Unit ○ *using the LAN interface* ○ *storing them in the removable hard disk with the associated session experiment raw data*	

	PACKING STEPS	A, B
22	Desinstallation of test subject	A & B
22.1	• Disconnection of EEG or EMG sensors from the headboxes	A & B
22.2	• Take away restrainers from test subject and stow back in ISS	A & B
23	In case of applications involving averaging markers (e.g. EPs) : Desinstallation of stimuli source items	A
23.1	• Switch-off stimuli source	A
23.2	• Desinstallation of subject items (ear plugs, flashing goggles or else...)	A
23.3	• Disconnection of stimuli/trigger source connector from trigger connector on front Panel	A
23.4	• Stow back Stimuli/Trigger items in their affectation	A
24	Close MEEMM Application on LTU	A
25	Switch –off Main Unit	A
26	In case of use of digitising tools : Disconnect camera and its Harness and stow back	A
27	Disconnect Headbox(es) and harnesses from the Main Unit	A
28	Stow back Headbox(es) and harness(es) in stowage drawer	A
29	Deinsert Hard disk and put it with the used-disks in stowage drawer	A
30	Sensor set desinstallation & Cleaning	A & B
	In case of EEG application : / In case of EMG application :	
30.1	Take-off EEG/EMG sensors	A & B

30.2	Stow back the cap in the used items to download	Throw away in trash collector used EMG electrodes	B
30.3	Destow cleaning wipes and Humid Towels if required		B
30.4	Clean the Subject Head using Humid Towels & cleaning wipes	Clean EMG electrode free locations with cleaning wipes	A & B
	Throw away in trash collector used cleaning wipes and Humid Towels		B

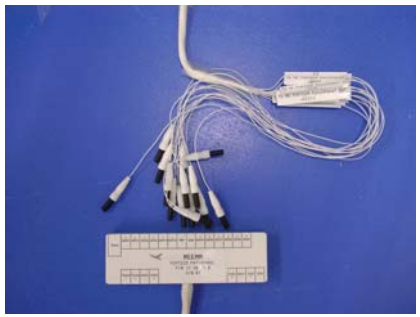
4.2.2.2 Ambulatory and sleep procedure

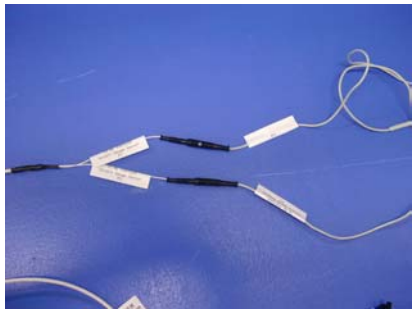
Two modes are planned for PORTEEM on-board operations :

- Stand alone recording
- Stand alone recording and occasional remote monitoring using the EPM laptop for signal quality check before recording. This mode is the most convivial one as its allows both to check what you are going to record and also to command the start/stop order using dedicated icons without requiring the use of the Vitaport 2 LCD and operating keys.

Step	Task		Crew concerned
	PREPARATION AND MONITORING STEPS		A, B
	Stand alone recording with occasional remote monitoring	**Stand alone recording**	
1	Destowage and preparation of the PORTEEM (MEEMM PORTEEM CORE UNIT) including 4 fresh batteries (MEEMM PORTEEM BATTERIES) & compact flash (MEEMM COMPACT FLASHDISK) and adapter (MEEMM COMPACT FLASH ADAPTER) 		A or B

1.1	• Unscrewing the door of the battery compartment and fix it on the velcropatch on the PORTEEM side • Place the batteries in the recorder base after. • Inspect the “+” and “-“ signs to ensure correct placement. • Screw back the battery cover 		A or B
1.2	• Insertion of flashdisk in PORTEEM		A or B
2	Fix the PORTEEM on the subject		A & B
3	Destowage of appropriate sensor harnesses (connection), sensors and accessories (held by test subject)		A or B
3.1	Destowage of cleaning wipes		A or B
3.2	Destowage of 12-electrode cap (MEEMM 12 EEG ELECTRODE CAP) and 1 syringe box (MEEMM SYRINGES BOX) Destowage of adhesive roller (MEEMM ADHESIVE ROLLER) and specific gluing cream (MEEMM SIGNA CREAM TUBE) for face individual electrodes		A or B
3.3	Destowage of Strain Gauge (MEEMM PORTEEM STRAIN GAUGE SENSOR+ MEEMM PORTEEM STRAIN GAUGE SENSOR) Destowage of EMG electrodes packets (MEEMM EMG SINGLE ELECTRODE) or (MEEMM EMG DUAL ELECTRODE) Destowage EMG (MEEMM PORTEEM EMG WIRE S/N 01 to 04) and ECG wires (MEEMM PORTEEM ECG WIRE S/N 01 to 02) Destowage of patchpanel (MEEMM PORTEEM PATCHPANEL)		A or B
3.4	Destowage of Optilink (MEEMM PORTEEM OPTILINK)	-	A or B

4	Preparation, mounting & functionality insurance of the electrode set. Installation time indication (RD18 “EPM/MEEMM Operational Analysis Report”) will be inserted in the procedures to guide the operator. For all steps of this task, photos will be added showing the positioning of the subject, the operator and the equipment and inserted as tear out pages in the on board user manual. These tear out pages will contain legend notes reminding the good tips related to the task. Refer to steps 13.1, 13.2, 13.3 and 13.4 of the stationary steps.	A & B
4.5	Connect the EEG cap (MEEMM 12 EEG ELECTRODE CAP) to the patchpanel (MEEMM PORTEEM PATCHPANEL) following the end labels on the cap plugs. 	A & B
4.6	Stow back empty syringes in the syringes box and in stowage drawer	A & B
4.7	Installation of EMG and ECG electrodes 1. For each individual electrode, the operator has to clean the skin for the electrodes and fix the electrodes (one by one or one pair by one pair according to the type of electrodes). 2. Connexion of the individual snapping buttons on the EMG & ECG electrodes already applied on the subject. The way to select the correct location a selected EMG/ECG electrodes will be described using schemes or pictures (tear out pages). 3. Connect the EMG (MEEMM PORTEEM EMG WIRE S/N 01 to 04) and the ECG wires (MEEMM PORTEEM ECG WIRE S/N 01 to 02) to the patchpanel following the end labels on the electrodes plugs..	A & B

4.8	Install the strain gauge sensor (MEEMM PORTEEM STRAIN GAUGE SENSOR)around the subject chest  Connect the strain gauge sensor ((MEEMM PORTEEM STRAIN GAUGE SENSOR) to the patchpanel (MEEMM PORTEEM PATCHPANEL) with the dedicated adaptor (MEEMM PORTEEM STRAIN GAUGE ADAPTOR) The way to Install the strain gauge sensor around the subject chest will be described using schemes or pictures (tear out pages).		A & B
5	Connect the Vitaport via the Optilink (MEEMM PORTEEM OPTILINK) to the laptop	-	B
6	Start the Columbus program	-	B
7	The subject power ON the recorder (not to be performed by the operator to avoid arc discharge) Press OK key to install VPDOS if asked on PORTEEM LCD		B
8	Select the correct Definition (or Montage) file using the PORTEEM SW. Note : the use of the the PORTEEM SW in the EPM environment is not defined yet.	Select the correct Definition (or Montage) file thanks to the recorder sub-menus displayed on the LCD, using the operating keys.	B
9	Install the subject		A & B
10	Start the acquisition		A & B
10.1	Click the “Connect recorder” button to allow exchanges between the recorder equipment and the Columbus SW	-	A & B

10.2	Perform visual control to check the quality and the sensitivity of the incoming signals before starting the actual recording. Using the Columbus IF (View on-line menu & Start view amplifier)	-	A & B
10.3	Start the recording by laptop via clicking the “Remote control” button and associated sub-menus	Start the recording by hand by simply pushing the OK key when the LCD displays “Start recording ?”	A & B
10.4	Click the “Disconnect recorder” button to end the exchange between the recorder equipment and the Columbus SW	-	A & B
10.5	Disconnect the Vitaport from the Optilink and the laptop	-	A & B

	RECORDING STEPS		A B (if on line monitoring)
	Stand alone recording with occasional remote monitoring	**Stand alone recording**	
11	Various functions can be monitored via the LCD (batteries, recording time…) With laptop re-connection, visual controls using the Optilink and the laptop can also be performed during the recording using the Columbus SW, without affecting the recording session.	Various functions can be monitored via the LCD (batteries, recording time…)	A & B
12	Stop the recording by hand by simply pushing the OK key when the LCD displays “Stop recording ?” With laptop re-connection, stop the recording by laptop via clicking the “Remote control” button and associated sub-menus	Stop the recording by hand by simply pushing the OK key when the LCD displays “Stop recording ?”	A
13	Disconnect the Vitaport from the Optilink and the laptop	-	A
14	Power OFF the recorder		A
15	Close the PORTEEM SW on the LTU	-	A

	PACKING STEPS		A
	Stand alone recording with occasional remote monitoring	**Stand alone recording**	
16	Deconnection of cap connector		A
16	Data archiving De-insert flashdisk from PORTEEM		A
17	Optional steps : Insert flashdisk in LTU and transfer data to the SMSC (To be completed)		A
18	Disconnect PORTEEM and harnesses		A
19	Stow back PORTEEM and harnesses in stowage drawer		A
20	Sensor set desinstallation & Cleaning		A
20.1	• Cap take-off		A
20.2	• Cap stowing back in the used items to download		A
20.3	• Subject Head cleaning (use of Humid Towels)		A

4.3 EXAMPLE OF COMPLETE SCENARIO ASSOCIATED DISPLAY

This paragraph provides various types of the MMI displays. MMI technical details are described in RD2 document (MEEMM SW User Manual).

4.3.1 STATIONARY EQUIPMENT

Here are the crew displays proposed by EREMS and INSERM Lyon for a classical P300 experiment protocol with 128 electrodes :

1) Impedance screen :
One screen with 4 views (sides, back and top) of the 128 electrode EEG cap placed on a subject head (photos taken on ground and inserted within the session profile). The screen is splitted within 4 parts.
The electrodes are numbered both on the cap and on the screen.

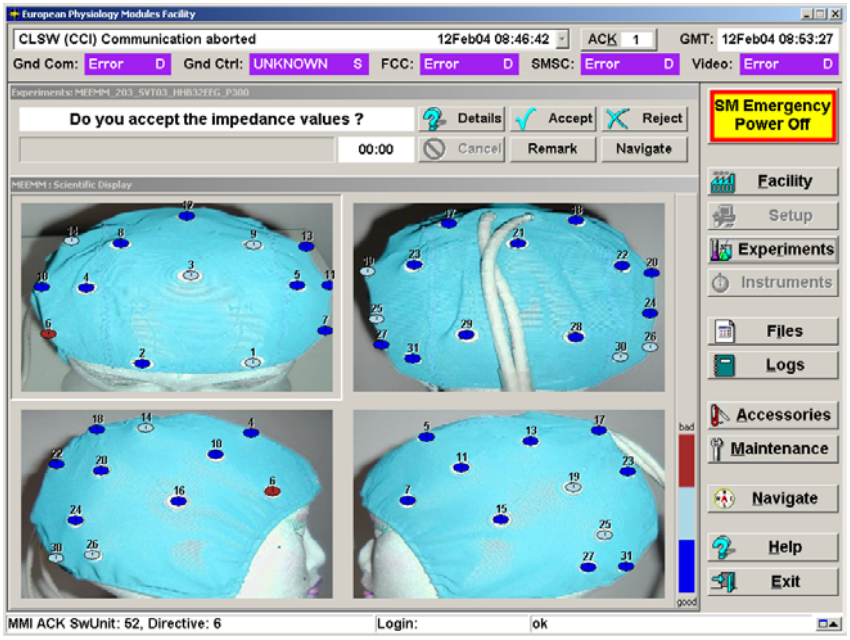


Figure 21 : Typical Impedance screen display (32 EEG cap)

Press OK button to accept the impedance values (impedance values storage with the session raw EEG data files)

2) EEG scrolling screens :
Scrolling of 8 EEG screens, each screen displaying 16 raw EEG curves. A fixed timer is used to go to one screen to the other within astronaut action. The EEG display scales will be defined within the session profile taking into account astronaut EEG ground sessions.

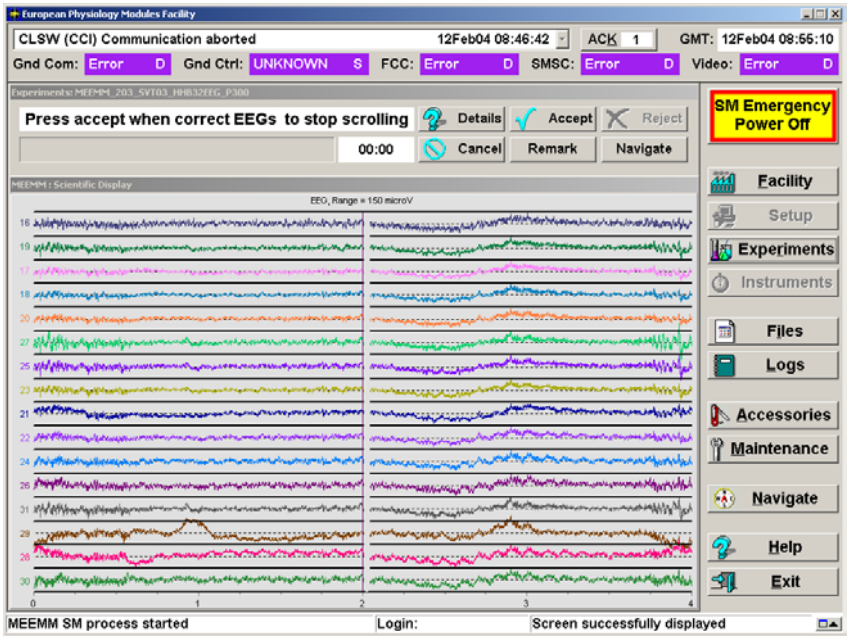


Figure 22 : Typical EEG scrolling screen display

Press OK button, once all the screens are corrects. The astronaut can be helped by paper support with his proper EEG typical responses, recording on ground during training sessions.

3) FFT screen :

One FFT screen displaying 4 to 8 FFT curves. The selection of FFT curves and display scales will be done within the session profile.

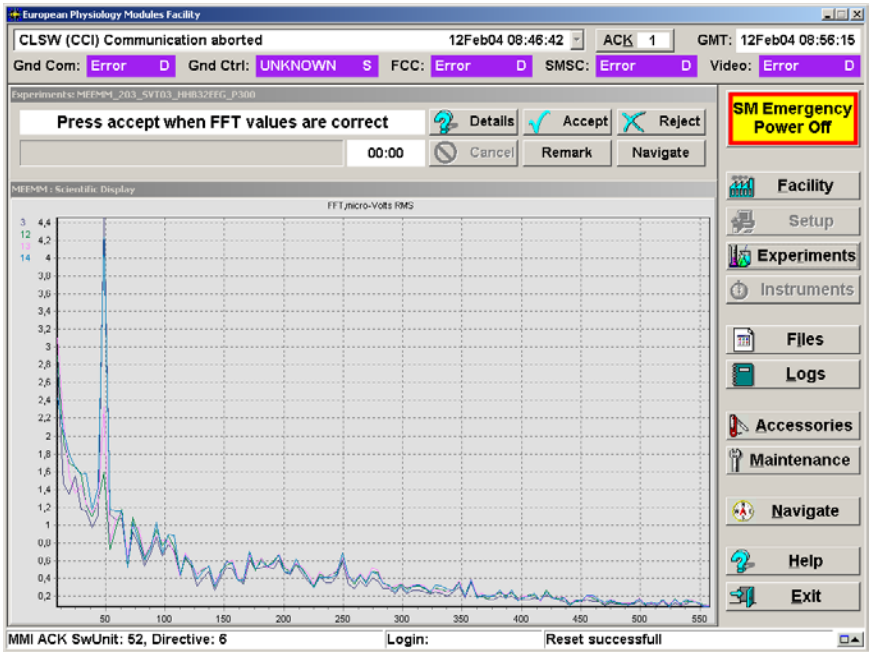


Figure 23 : Typical FFT screen display

Press OK button, once all the FFT are corrects. The astronaut can be helped by paper support with expected FFT responses.

4) Session monitoring screen :
One screen is required, splitted vertically in 2 parts.
Fist part : One EEG screen (10 s duration) with up to 16 raw EEG curves. The EEG display scales will be defined within the session profile taking into account astronaut EEG ground sessions.
Second part : 2 EP zones (1 EP zone = 1 trigger class) with one or more electrodes (EPs parameters selected within the session profile).

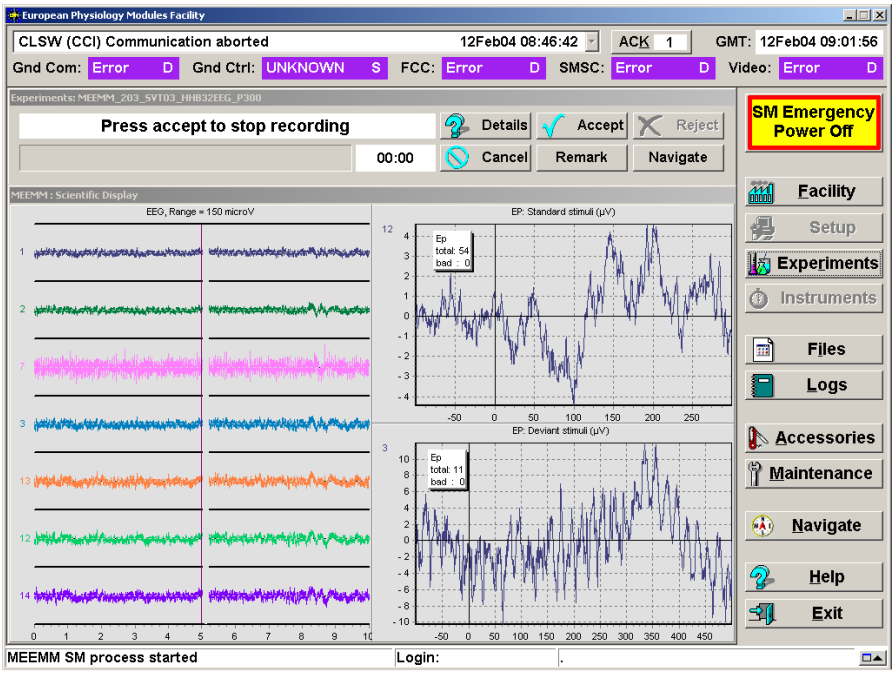


Figure 24 : Typical session monitoring screen display

Press OK button, once all the acquisition are correct (stimulator, stressors OK, EEG), to begin the recording (EP reset).

The operations linked to the stimulator have to be defined as it impacts on the MEEMM start/stop recording protocol and raw data sub files management.

4.3.2 AMBULATORY AND SLEEP EQUIPMENT

The PORTEEM equipment is a standalone equipment. Occasional monitoring are possible in case of temporary PORTEEM connection with the LTU using the Optilink harness.

In case of monitoring using PORTEEM SW (refer to RD23 “Columbus User’s manual”), no screen sequence are used, only one on line screen can be displayed.

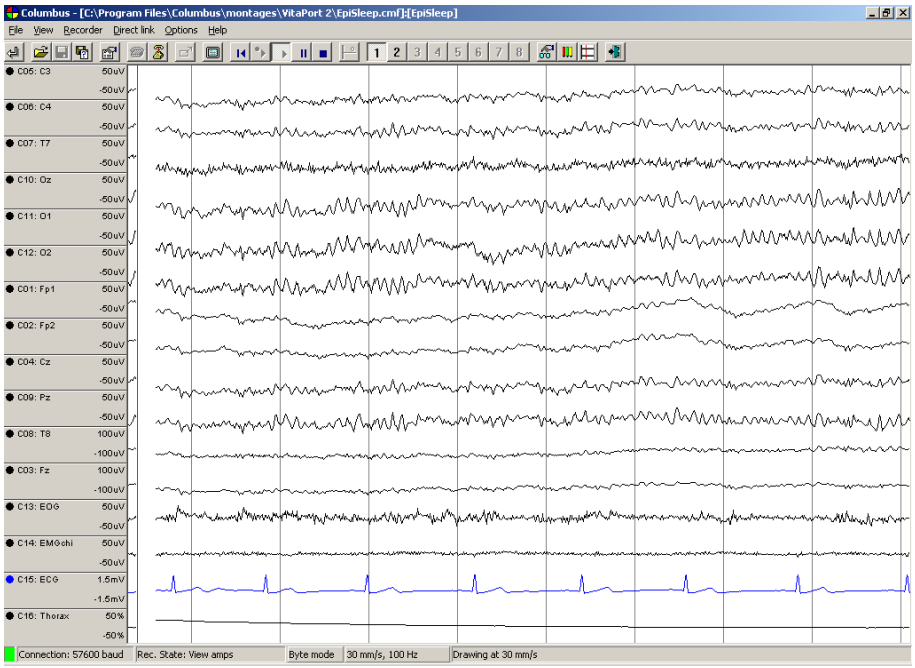


Figure 25 : Typical signals for PORTEEM sleep session

5 MAINTENANCE PLAN AND INSTRUCTIONS

This section will be completed at a later stage to cover the following information (synthesis of AD7 "EPM/MEEMM Maintainability Assessment and Inputs to Maintenance Plan") :

- Plan and instructions for preventive maintenance
- Instruction for corrective maintenance
- Required tools and skills for maintenance

At the moment, these information are provided within AD7 "EPM/MEEMM Maintainability Assessment and Inputs to Maintenance Plan".

Two main connectors are available for maintenance and trouble shooting :

- Test Link (J05)
- SW Download (J08)

Refer to paragraph 7 for connector pin out.

The SW procedures linked to trouble shooting operations are described in the dedicated "SW user Manual" (refer to RD2).

6 SPECIAL TOOLS

The list of standard tools needed for the MEEMM operation, installation or maintenance is the following :
It has to be noted that some of these tools will not be used in the baseline option for MEEMM headboxes fixation on the rack (use of velcro instead of Seat track).

Tool Name	Document-chapter where tool is described	Tools required for
Routing cleaning/disinfection	AD5 Section 8	Cleaning of skin of the test subject and of his head after experiment sessions
Trash collection and trash compaction	AD5 Section 8	Collection of the used consumables after experiment
Personal restraints	AD5 Section 8	Restraint of the test subject during experiment sessions and restraint of the operator nearby the test subject when fitting the cap and electrodes on the test subject
Tool kit P-Consumables Duct tape	AD5 Section 8	Fixing of the cap harness on the shoulder of the subject during experiment
Tool kit P-Consumables wet and dry wipes	AD5 Section 8	Cleaning of skin of the test subject and of his head after experiment sessions
Tool kit P-Consumables Velcro	AD5 Section 8	Fixing of deployable items
Articulating Post Assembly (AP) Part nbr G11F5122-1	RD14 chapter 1.2 « Equipment Restraints »	Fixing of Headboxes to Seat Track (AP fixed on Seat Track)
Seat track Equpment Anchor Assembly (STEA) Part nbr G11F5120-1	RD14 chapter 1.2 « Equipment Restraints »	Fixing of Headboxes to Seat Track (STEA fixed on AP)
Adjustable Length Tether Assembly (ALT)) Part nbr G11F5140-1	RD14 chapter 1.2 « Equipment Restraints »	Fixing of Headboxes to Seat Track (ALT fixed on STEA, ALT straps the Headbox (es))

Table 9 : COLUMBUS / ISS standard tools used by MEEMM

The list of MEEMM specific tools or equipment needed for the installation, deinstallation, operation or maintenance is the following :

Tool Name	Operation the tool is required for	Reason why no COLUMBUS standard tool could be used
Compact flash disk adapter	OPERATION used for camera mini flash disk to adapt it to standard flash disk size	MEEMM specific
Calibration plug	MAINTENANCE (preventive) used for calibrating MEEMM amplifiers	Adapted to MEEMM specific connector
Downloading plug	MAINTENANCE (preventive/corrective) used to allow downloading of Supervisor SW by crew or by ground	Adapted to MEEMM specific connector

Table 10 : Tools provided by MEEMM

Note : The MEEMM SM requires an external stimulator for most of the experiments (Evoked Potentials).

The environment conditions are very important when making Evoked Potential measurements; as their objective is to study the reaction of the brain to specific stimuli (for example visual) the subject should be in a calm environment (avoiding for example flashing leds or sounds which would completely change the responses of the brain).

7 SCHEMATICS, WIRING AND LOGIC DIAGRAM

This section includes some information required to support maintenance and trouble shooting :

The MEEMM front panel is presented on the Figure 26.

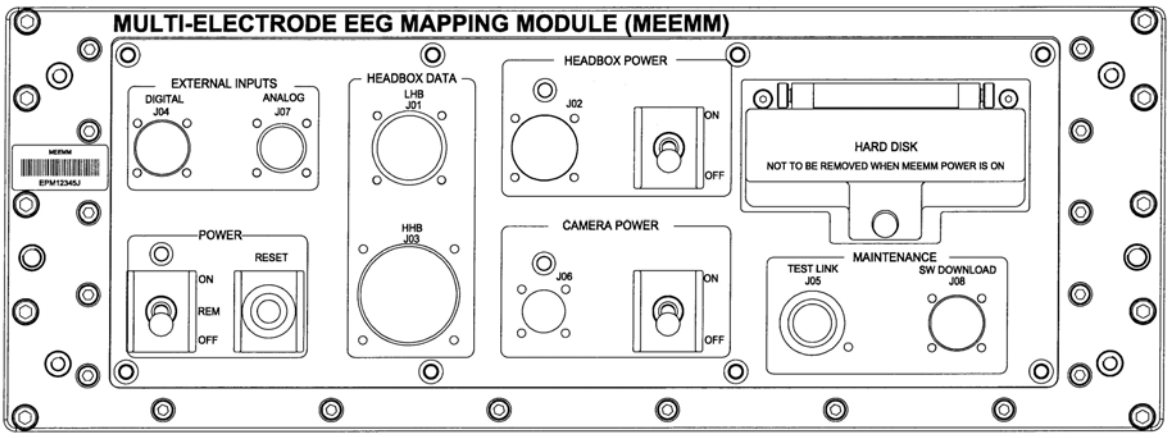


Figure 26 : MEEMM main unit front panel

Two main connectors are available for maintenance and trouble shooting :

- Test Link (J05)
- SW Download (J08)

The pin out of these two connectors is provided in the tables here below.

Connector	Pin	Signal
J05	1	RS422 SMTest/Diag TxData
	2	RS422 SMTest/Diag TxData_S
	3	RS422 SMTest/Diag TxData_R
	4	RS422 SMTest/Diag RxData
	5	RS422 SMTest/Diag RxData_S
	6	RS422 SMTest/Diag RxData_R
	7	Test link SPVR 1
	8	Test link SPVR 2
	9	Test link SPVR 3
	10	NC
	11	Test link SPVR 5
	12	Test link SPVR 6
	13	NC
	14	NC
	15	NC
	16	NC
	17	NC
	18	NC

Connector	Pin	Signal
J08	1	Structure GND
	2	GND
	3	CPU_board_J11 GREEN
	4	CPU_board_J11 RED
	5	CPU_board_J11 GND
	6	CPU_board_J11 SCLK
	7	GND
	8	Select Main/Red
	9	CPU_board_J16 KBCLK
	10	CPU_board_J16 VCC
	11	SPVR Telech_R
	12	SPVR Telech
	13	CPU_board_J15 VCC
	14	CPU_board_J15 MDATA
	15	CPU_board_J15 MCLK
	16	CPU_board_J11 BLUE
	17	CPU_board_J11 SDATA
	18	CPU_board_J11 VSYNC
	19	CPU_board_J16 GND
	20	CPU_board_J16 KBDATA
	21	CPU_board_J15 GND
	22	CPU_board_J11 HSYNC

- All the maintenance tasks are described in AD7 “EPM/MEEMM Maintainability Assessment and Inputs to Maintenance Plan”.

8 TRANSPORTATION, PACKAGING, HANDLING AND STORAGE

For transportation and storage , the MEEMM containers comply with the requirements specified in AD3 “Science Module Interface Requirements Document (SMIRD) for the European Physiology Module”.
It has to be noted that the MEEMM containers includes some limited life items (refer to RD24 “Delivery Item List”). These items have to be stored in classical environment (ambient temperature, 50% humidity).

The delivered material has been cleaned at EREMS, standard FM cleaning rules have to be applied at the integration sites.

The list of delivered MEEMM items and the content of each containers (4 mains containers) are provided in the shipment list of the ADP.
All the items are separately enclosed in antistatic pockets. The following photos present the container organisation.
Container 1 : MEEMM Main Unit

Container 2 : Headboxes, HD, harnesses


Container 3 : Caps and consumables


Container 4 : GSE items.

9 INSTALLATION PROCEDURE

This paragraph describes the installation steps of the MEEMM and its GSE environment in standalone configuration.

9.1 MEEMM/GSE SET-UP

The general GSE configuration is depicted in the following figure. This configuration includes the MEEMM Main Unit and the GSE.

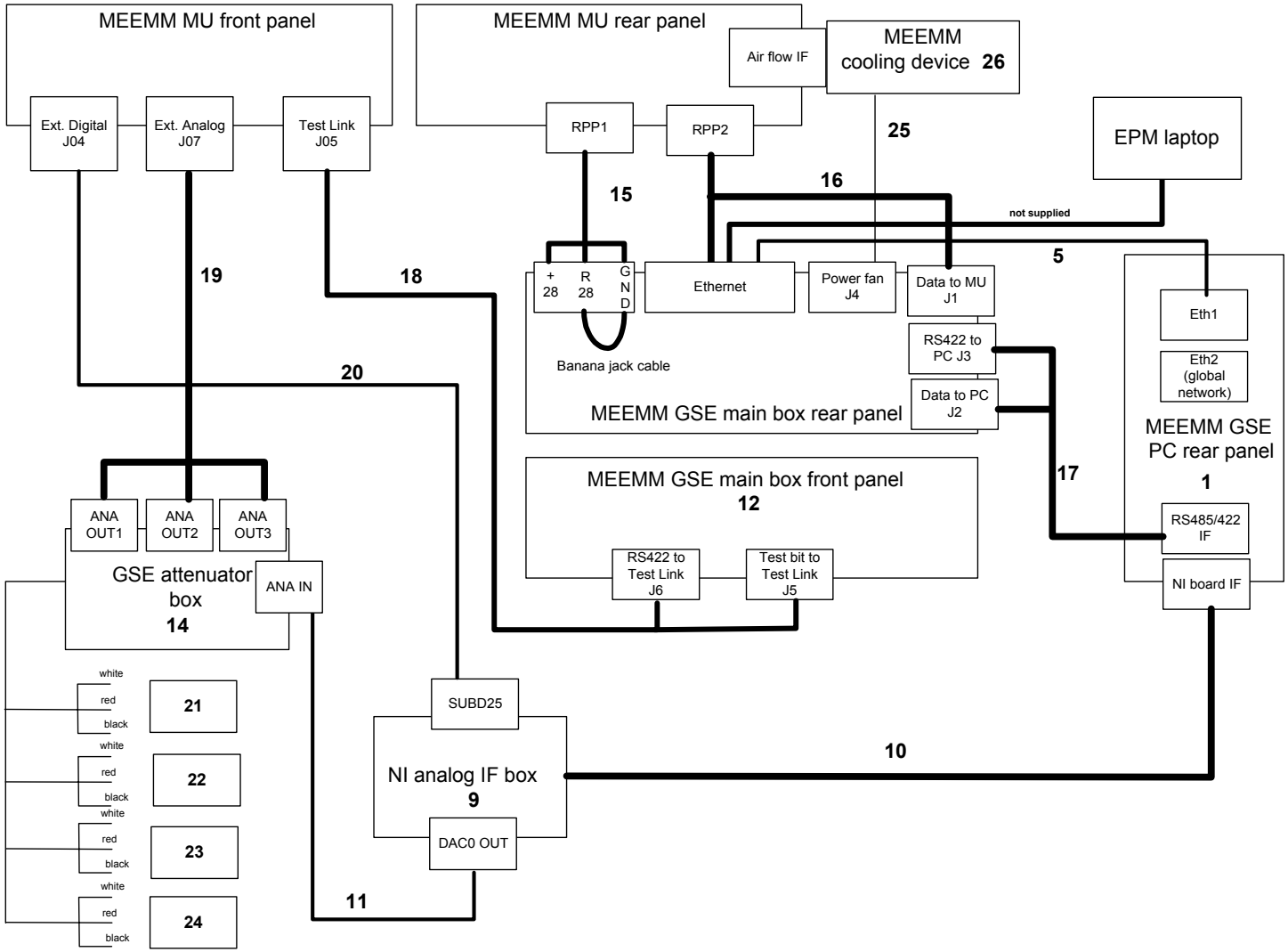


Figure 27 : Acceptance test GSE configuration

The MEEMM GSE items lists is provided in the table here below :

ITEM N°	CLASSIFICATION / ITEM NAME	PART NUMBER	LABELLING
1	GSE PC Main Unit including: -Trigger EEG simulation Unit (NI Analog Outputs board) -HW SMSC if simulation (Aksys RS422/485 board) - HDD – IDE cable	12.55.43.1	MEEMM GSE PC Main Unit (MEEMM GSE Harness HDD IDE on the HDD IDE cable)
2	GSE PC Screen	12.55.43.2	MEEMM GSE PC Screen
3	GSE PC Keyboard	12.55.43.3	MEEMM GSE PC Keyboard
4	GSE PC Mouse	12.55.43.4	MEEMM GSE PC Mouse
5	GSE PC Ethernet cable	12.55.43.5	MEEMM GSE PC Ethernet Cable
6&7	GSE PC Power cables (x2)	12.55.43.6	MEEMM GSE PC Power cable
8	GSE PC VGA screen cable	12.55.43.7	MEEMM GSE PC VGA Screen Cable
9	National Instrument analog IF box	12.55.23.1	MEEMM National Instrument analog IF box
10	National Instrument analog IF cable	12.55.23.2	MEEMM GSE NI analog IF cable
11	BNC cable	12.55.23.3	MEEMM GSE BNC analog cable
12	GSE Box including: -28V power supply -5V power supply -Ethernet Switch	1255221	MEEMM GSE Box
13	GSE Box Power cable	1255222	MEEMM GSE Box Power Cable
14	GSE attenuator box	1255240	MEEMM attenuator box
15	GSE_RearPanel_PWR	12.55.11.0	MEEMM GSE Harness Rear Panel Power
16	Rear panel data to 50 points	12.55.12.0	MEEMM GSE Harness Rear Panel Data
17	GSE_RS485/50points	12.55.13.0	MEEMM GSE Harness RS485 / 50pins
18	GSE_TestLink	12.55.14.0	MEEMM GSE Harness Test Link
19	GSE_Analog_Sources	12.55.15.0	MEEMM GSE Harness Analog Sources

ITEM N°	CLASSIFICATION / ITEM NAME	PART NUMBER	LABELLING
20	GSE_Trigger	12.55.16.0	MEEMM GSE Harness Trigger
21 to 24	LHB_MELJ01/2_EEG (EEG plugs) (x4)	12.55.18.0	MEEMM GSE Harness EEG Plug
25	Sub-D 9 pins extension cable	12.55.19.0	MEEMM GSE Harness SubD 9 cable
26	Cooling device	12.55.21.0	MEEMM Cooling device

Table 11 : MEEMM Tools items list

9.2 INSTALLATION STEPS

No specific order is required in the steps to install the GSE complete set-up referred in Figure 27. De-stow all the required items (referred in Table 11) and connect them as describe on the scheme, with the help of the labelling on the harnesses ends.

Refer to RD29 “EPM/MEEMM Acceptance test procedures” for examples of standalone procedures.

9.3 GROUND INSTRUCTIONS OF USE

The Payload and GSE Operation Manual is the main document providing detailed documentation, data and instructions for operations and maintenance of the payload and ground segment equipment (GSE).
This document refers to 3 others User Manual dedicated to SW and Digitizing tasks for some specific operations:

- **RD2 :EPM/MEEMM SW User Manual**
  This document describes the use of MEEMM SW
  The intended readership of this document is :
  - OHB personal be able to operate the MEEMM during test and integration
  - Profile developer, i.e. people in charge of developing a scientific session using MEEMM.
  - Test engineers, as the content of this document shall be known for writing test scripts.

- **RD25 : EPM/MEEMM SW Transfer Document**
  This document identifies the MEEMM Softwares and how to build and install it in the operational environment.
  The document is updated after main SW releases.

- **RD26 : EPM/MEEMM 3D Electrodes Modelling User Manual**
  This document is in charge to explain the way to proceed to obtain the electrodes location thanks to the Photomodeler software.

Additionally, a synthesis of data and requirements to support the MEEMM/EPM ground integration phase is provided in “**Ground Processing data” (RD10).**

Following the assessments performed in RD30 (CE declaration of conformity), the following usage recommendations or restrictions have to be made. They are mentioned in the CE certificate which is given in Appendix of RD30 :

- MEEMM class is 2A
- The CE directive applied is the ANNEX VIII of 93/42/CEE:
  MEEMM is a custom-made device**:** MEEMM device was specifically made in accordance with the European Space Agency (ESA) written requirements with specific design characteristics.
  GM1, GM2 and BDCM are intended for the sole use of particular Centers in relation with the European Space Agency (ESA) linked with the operation (preparation/exploitation) of the Flight Model onboard the International Space Station.
  It shall not be used for clinical investigations.

- It complies with the essential relevant requirements of ANNEX I of 93/42/CEE and of IEC 601, with the following exceptions and with restrictions of usage:

  - Taking into account the very specific usage, the MEEMM Operation Manual (operating instructions) is based on a template for the space flight model and differs from the indications shown in the Directive

- Regarding the labelling, taking into account the Space Flight requirements and the similarity contraint on the Ground models, the labelling and markings are also in discrepancy with the Directive

- Discrepancies exist with all sections of IEC 60601 taking into account the Usage specificities. In particular, the main discrepancies (but not exhaustive) are

  - The normal condition for the test subject is to be electrically floating, not linked to the ground

  - Regarding the Section 3 Article 19 « leakage currents… », the “NASA Medical Safety Standard”, App. Y: “IRB guidelines regarding In-Flight Electrical Standards associated with bioinstrumentation to be used for in-flight investigative monitoring of shuttle crewmembers” (JSC20483 App. Y) was applied. The values indicated in the IEC 601-1 are covered when MEEMM is used alone.
    Still , and even when MEEMM is used in combination with other medical systems, the test subject shall be electrically floating, not linked to the ground. Moreover in case of combination with other medical subsystem, depending on their characteristics, the user will have to take care of the possible risk with the addition of leakage currents

  - Another EMC standard than the EC directive one (cf section 5 of IEC 601) was applied on MEEMM. This standard is specified in document EPM-OHB-RQ-006 1/C (corresponding to the International Space Station EMC Environment).
    MEEMM was tested according to this Standard for Conducted Emission, Conducted Susceptibility, Radiated Emission, Radiated Susceptibilty, ESD Tests. The results are shown in the report EPM-ERM-TRP- 0004, 03/03/03.

- Regarding electrical installation
  For GM1 and GM2, MEEMM shall be used only with the Main Unit integrated and powered in the EPM rack
  The BDCM shall be used only with the Main Unit powered by the MEEMM GSE.

- No defibrilator shall be used when using MEEMM

- Care shall be taken by the user on the position of the electrodes on the test subject, so that no stimulation can go through the Thorax

10 SPARES PARTS LISTS

This section will include the list of the spare parts for MEEMM in service replacement / repair.

The following list is extracted from RD24 “Delivery Item List”.

Deliverable items / Models	**FM**
Spares	
CAM board set (1 CPU, 2 DSP)	1
Rough PCBs and associated connectors for the custom-made boards of the MEEMM main unit and headboxes	1 per board type
Front panel / LHB / HHB interface connectors	Complete set
MEEMM Harness connectors	1 per type
Electrical components	1 set to allow the manufacturing of each board type
Camera	1
Compact flashdisk	1
Compact flashdisk adaptor	1
Vitaport acquisition main unit	1 common with ground models
16 channel polysomnography module	1 common with ground models
Up and down / spares consumables	
Main unit Hard disk	5
32 electrode EEG cap	3 different sizes
64 electrode EEG cap	3 different sizes
128 electrode EEG cap	3 different sizes
PORTEEM 12 elect. EEG cap	3 different sizes
PORTEEM Flashdisk	5
Syringes boxes including each 8 syringes with needles and gel	7

11 POST FLIGHT REFURBISHMENT

Not planned.

12 SKILL/TRAINING REQUIREMENTS

Refer to paragraph 4.2.1.1.1 Crew preparation:.